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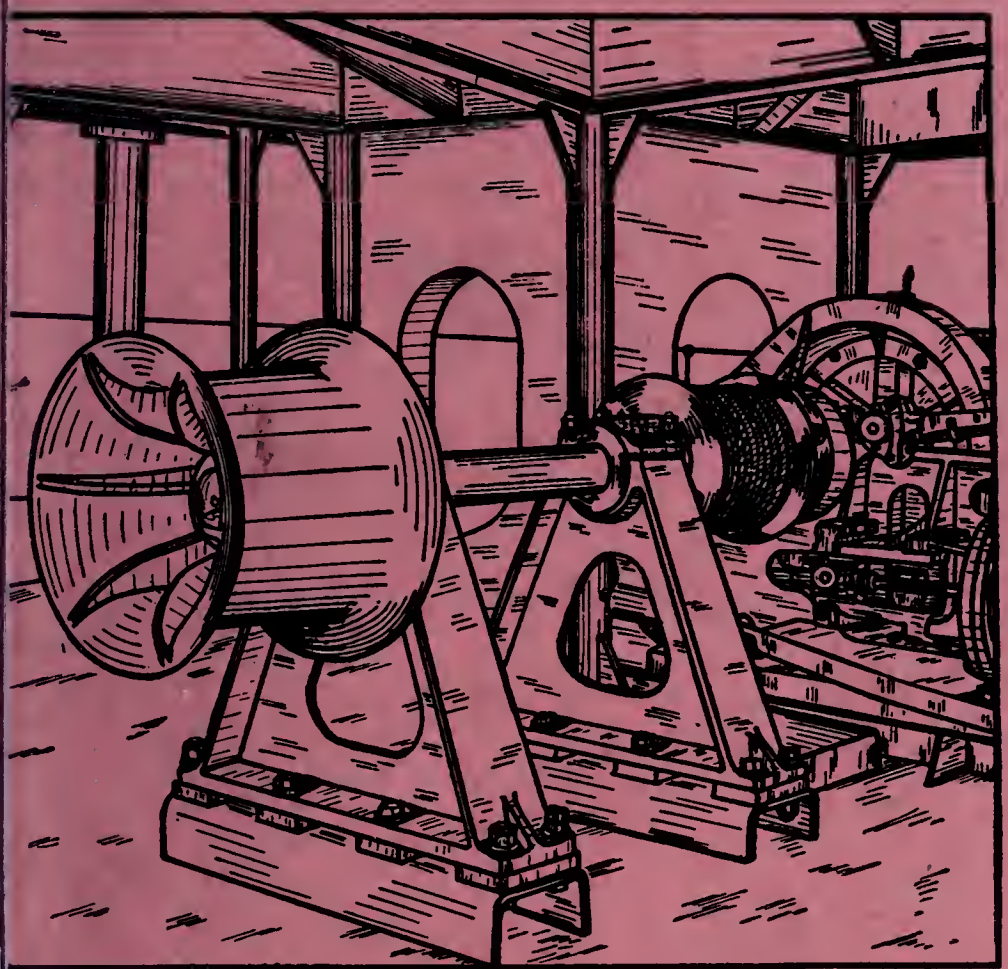
A Suggested Unit Course

SHIPYARD OUTSIDE MACHINIST

(For Beginning and Advanced Instruction)



BULLETIN 345-K

Commonwealth of Pennsylvania

DEPARTMENT OF PUBLIC INSTRUCTION

Harrisburg

1942

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Vocational Training
for
War Production Workers

Boring a Stern Frame Rudder Gudgeon

A Suggested Unit Course

SHIPYARD OUTSIDE MACHINIST

(For Beginning and Advanced Instruction)

Bulletin 345-K

Prepared by the

COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF PUBLIC INSTRUCTION
DIVISION OF INDUSTRIAL EDUCATION

In Cooperation With

SUN SHIPBUILDING AND DRY DOCK COMPANY
CHESTER, PENNSYLVANIA

SCHOOL DISTRICT OF PHILADELPHIA

SCHOOL DISTRICT, CITY OF CHESTER

and

UNITED STATES OFFICE OF EDUCATION
FEDERAL SECURITY AGENCY

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Commonwealth of Pennsylvania
DEPARTMENT OF PUBLIC INSTRUCTION
Harrisburg
1942

This Material Was Prepared
In Cooperation With The
United States Office of Education
The Federal Security Agency
Washington, D. C.

Foreword

rapid expansion of shipbuilding, with an accompanying increase in the number of yard outside machinists to be trained, has prompted the development and publica- of this manual of instruction.

he procedures presented here are specifically those which are followed in the yard he Sun Shipbuilding and Dry Dock Company. Persons who have developed this rial realize that certain procedures may not be applicable to all types of shipyards. h of the information presented, however, is standard practice which will be useful aining shipyard outside machinists for most shipyards.

hrough the courtesy of the Alabama State Department of Education, certain items nstructional material have been selected from their training course for Shipyard side Machinists and adapted to fit local requirements.

cknowledgment is made to the Sun Shipbuilding and Dry Dock Company, Chester, nsylvania, and to foremen, mechanics, and draftsmen employed by the Sun Yard for stance and cooperation in making the preliminary analysis and in preparing in- ction materials.

pecial acknowledgment is extended to George Ebaugh, General Foreman of Instal- on Machinists; to William Evans, Foreman of Installation Machinists; and to E. G. nberson, Foreman of the Tube Mill. These men assisted materially in the prepara- n of text matter, sketches, and photographs; they served also in the capacity of tech- al advisers. The assistance of George Amrhein, E. L. Moritz, G. E. Marvel, J. W. ndall, James Galway, Joseph Kehl, and Ralph Garman, Leaders of Installation chinists, is gratefully acknowledged.

Appreciation is extended to the Philadelphia School District; to the Chester School strict; to D. Francis Hallowell, Coordinator of Chester Area Defense Training Pro- am; and to William A. Brock, Area Coordinator of Industrial Education, for assist- ce in this work.

Acknowledgment is also extended to the Cramp Shipyard, Philadelphia, and to J. Campbell, Outside Machinist Instructor, Mastbaum Vocational School Annex, hiladelphia, for assistance in the preparation of suggested types of training jobs in rrelation with instruction sheets contained in this manual.

This manual of instruction was prepared by the Chester Field Curriculum Labora- ry of the Pennsylvania Department of Public Instruction, under the immediate super- sion of Charles Johnston, Adviser, Division of Industrial Education. The work was mpleted under the direction of Charles F. Zinn, Adviser, Division of Industrial ducation, and under the general supervision of Paul L. Cressman, Director, Bureau f Instruction, and Urwin Rowntree, Chief, Division of Industrial Education.

FRANCIS B. HAAS
Superintendent of Public Instruction

ctober, 1942

Introduction

DUTIES OF A SHIPYARD OUTSIDE MACHINIST

)yard outside machinists are required to make certain installations, above and below
ς, throughout the ship. The equipment to be installed is fabricated in various de-
:ments of the shipyard or purchased from approved manufacturers.

'he work of the outside machinist may start when the hull begins to take shape,
ending altogether on the circumstances which govern the fabrication of units built
he shipyard, the speed of hull construction, and the availability of purchased units.
ome cases the work of the outside machinist is 75% completed before the ship leaves
ways. At other times the greater part of the work is not started until the ship is
nched.

APPLICATION OF THE MANUAL

e manual *Shipyard Outside Machinist* may be applied to the training of the begin-
g workers, advanced workers, and maintenance and repair outside machinists. It is
igned principally for the guidance of shipyard outside machinists, that is, those
chinists whose work is done around the wet basins and on the ways. Many of the
)cesses and operations presented are also applicable to shop machinist's training
)blems. This outline is specifically intended for training outside machinists (Ma-
e) ; it is not intended for instruction of general shipyard shop machinists.

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PART I

OUTSIDE MACHINIST TRAINING FOR BEGINNERS

PART I

*Safety

SICAL REQUIREMENTS

Physically a shipyard outside machinist will need to meet no spec- requirements other than that he have no physical handicaps, since work calls for use of all his faculties and limbs. He must neces- ily be healthy because the work is physically hard. To be a success- mechanic, one should be mechanically inclined and able to analyze specific job he is called upon to do.

LTH

Knowing that the loss of an eye, limb, or health may impair his fulness in his trade, a mechanic should be careful to acquire correct its in performing his work. In going up and down ladders and compan- ways he should face the ladder or companionway. In climbing, he uld make certain of good hand holds and sure footings. He should p his balance at all times while working on scaffolding and make a ctice oi avoiding awkward positions during all operations performed le on a scaffold. Rope-hung scaffolding should be anchored with tie es to prevent swaying.

Hazards

There are a few hazards that, perhaps, are peculiar to the ship- d outside machinists' work and deserve special attention, namely; e danger of fire and explosion from gas and inflammatory material in pe lines, pumps, etc., and the danger of someone's releasing steam or t water into an open pump or pipe line around which work is being per- rmed.

PLOSIONS AND FIRE

Explosions and fires are most likely to occur aboard tank ships at have carried inflammatory or explosive cargoes previous to work ing done upon them. Cargo tanks are "gas freed" before repair work is arted on them. The workman should check with the chemist before arting work, for the pipe line may still contain dangerous liquids or ses. The only safe procedure in disconnecting equipment that has con- ined or may still contain dangerous materials is to disconnect the uipment to be worked upon and take it out into the open. If it is cessary, a hacksaw or chisel may be used to work on equipment, but ere is still danger of friction heat or a spark causing a serious ac- dent.

It should be remembered that fuel lines and tanks on any type of ip present the same fire and explosive hazard as lines on tank ships.

STEAM AND HOT WATER

Steam and hot water lines may be temporarily freed of steam or water by closing a valve between the equipment to be worked on and source of steam or hot water. The problem is to prevent the valve being opened until it is safe to open it. Locking the valve, discor ting and capping the pipe, or blanking out a flange coupling betweer work and the valve are safe practices. Be sure to remove the bl when the job is finished. Signs on a valve are not trustworthy bec there are workmen who do not believe in signs.

All manholes, hatches, and other openings normally are covere closed. When it is necessary to open these covers to get at through these openings, a helper should stand guard to keep someone falling into the opening and to prevent someone's replacing the c and locking anyone inside. While this may not be fatal, at least i an unpleasant experience.

Shafts and other equipment are lowered into and pulled out of hold of a ship by means of ropes. These ropes must be tied secur and they must be in good condition. If there is a connection on shaft, any good knot will be sufficient to hold; but where there i connection, two clove hitches should be tied around the shaft to it. A clove hitch is not difficult to tie. It is used because it tighter as the pull becomes greater, and when the pull is slacked of is easy to untie. See Fig. 1. Other forms of slings and lifting vices are employed for certain jobs. Such information will be giver connection with the job later on.

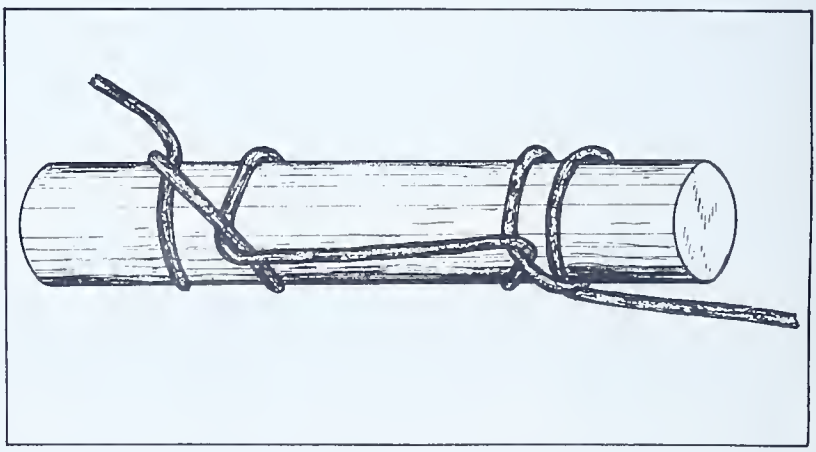


Fig. 1

When lifting a crank shaft, precaution should be taken to keep shaft from turning. If the shaft should turn while lifting, there danger of serious injury in someone's getting caught between the turn crank and a stationary object.

Before lifting a heavy load with a steel cable, the operator sho carefully examine the cable for defects and kinks.

Never use connected shackles where additional length is required lifting a load. Secure a steel sling of the proper length.

When lifting extra heavy loads, fasten with pads welded to the d instead of shackles and beam clamps. The welded pad will not p or break as easily as the shackles and clamps.

Keep on guard and in the clear as much as possible when using vy strong backs and pull bolts with hydraulic jack. If something uld break or slip there is danger of personal injury.

Always keep entirely out from under lifted loads. Any load is kely to slip or break loose.

Be extremely careful when opening up cargo pumps and valves in go line. There may be gas in line or pump which may cause a fire.

When working on boilers where one boiler has steam on it, be re that the valves do not leak before opening up. In some cases, anks have to be used in the boiler feed line, auxiliary steam line, d the blow-down line. Be sure to remove blanks when job is finished. en working on boilers, one of which has steam on, the man in charge the job should lock the connecting valve between the boilers with chain and padlock.

Wear goggles at all times when using grinding wheels or chipping ns, also when using hot bearing metal.

Keep tools in good condition at all times.

In hooking or tying loads always use wire cable sling in preference to a chain.

When eye bolts are used for hooking heavy loads, the bolt should e screwed down full to the eye. If threads will not permit this, use shers or nuts as spacers. Keep cables as nearly vertical as possible.

Never use two hand hammers or sledge hammers against each other. f necessary to use a handle tool, secure backing-out hammer or set ammers to place against the work. When hand hammers or sledge hamers are hit together, a piece is likely to chip off because of their egree of hardness, and cause personal injury. This practice is especially dangerous because it invites eye injury.

Use common sense at all times to avoid injury. Determine the afest method to do a job and do it the safe way even though it may ake a little more time.

QUESTIONS AND ASSIGNMENTS

1. What are the physical requirements for an outside machinist?

2. Name some of the hazards of the shipyard outside machinist trade.

3. Under what conditions are explosive gases encountered?

4. What precautions should the workman observe when working where explosive gas may be encountered?

5. What safety measures should be taken when working on steam, gas, hot water, or oil connections?

6. What precautions should be taken while working in manholes or similar openings?

7. Demonstrate the proper method of tying a rope around a shaft.

*Adapted from "Shipyard Outside Machinist" by State Department of Edu tion, Alabama.

Location of Shops

New men should become familiar with the locations of the vari store rooms, tool rooms, stock piles, and other places about the shi yard. Instructions are given to new men by the group leader or sc person whose responsibility it is to instruct new men as soon as th reach the yard.

Outside machinists and helpers are called upon to get materia tools, and equipment from many parts of the shipyard during the cour of a day's work. It is the duty of every man employed on the job give strict attention to instructions about how to find his way arou in order that no time may be lost.

The store rooms are usually located immediately under the wa upon which the ship is being erected. Tool rooms, where vario tools and special equipment are kept, are located at certain poin in the shipyard where they may be reached in a reasonable length time. The workman's badge must be shown at all tool rooms and sto rooms, and necessary orders for materials must be obtained from gro leaders before such tools and supplies will be issued. Keep this mind and save time and confusion. Workmen who are not sure shou ask someone in authority before starting out on an errand.

Be on the alert at all times when crossing the yard or when wal ing along traffic lanes. Watch for overhead hazards, and avoid ma ing the other fellow try to guess what you are going to do next. not change direction quickly without first making sure the way clear.

Tools and Equipment

'IRST CLASS OUTSIDE MACHINIST IS EXPECTED TO HAVE THE FOLLOWING TOOLS:

1. 6" Steel Scale
2. 6' Steel Tape
3. Combination Square, 12" Blade with Centerhead and Protractor
4. 10" Lock Joint Inside Caliper - of Different Sizes
5. 8" Lock Joint Outside Caliper
6. 8" Dividers
7. 10" Dividers
8. 8" Hermaphrodites
9. 1¼ lb. and 1⅝ lb. Machinists' Hammer (Ball Peen)
10. 4" Prick Punch, Size D, Starrett Catalog No. 26 or equal
11. 5" Center Punch, Size E, Starrett Catalog No. 26 or equal
12. Hack Saw, 12"
13. Tin Snips, 10" to 14"
14. Open End Wrenches up to 1 inch
15. Screw Driver, 6" to 10"
16. 6" Level
17. Pocket knife
18. Plumb Bob and Line
19. Scriber
20. Thickness Gauge, .002 to 1/16 inch or more
21. Several Adjustable Wrenches, Suggested Sizes: 4", 6", and 10"
22. Stillson Wrench, 14"
23. 10" Monkey Wrench
24. 6" Pliers
25. Set of 12 Point Box Wrenches up to 1" Size

Tools and Equipment

TOOL CRIB: TOOLS FOUND IN TOOL CRIB, USUALLY COMPANY OWNED

1. 50' Steel Tape
2. Files: Assorted
3. Cold Chisels: Flat, Round Nose, Gouge, Cape, Diamond Point
4. Reamers: Hand, Shell, Roughing, Taper
5. Hack Saw, 12"
6. Tin Snips, 10" to 14"
7. Drift Punches, 1/8" to 3/8", Assorted Sizes
8. Caulking Tools: Air
9. Fox Wedges
10. Taps and Dies
11. Chalk Line
12. Hand Scraper
13. Flat and Bull Nose Scraper
14. Straight Scraper
15. Three Corner Scraper
16. Micrometer
17. Straight Packing Hook
18. Screw Packing Hook
19. Approved Set of Goggles
20. Oil Stone
21. Drifts and Drift Punches
22. Stillson Wrench over 14"
23. Drills
24. 12 Point Box Wrench
25. Hexagon Box Wrench
26. Trammels
27. Straight Edge: 2' to 8'
28. Socket Wrenches
29. Thread Gauge

General Arrangement of a Ship

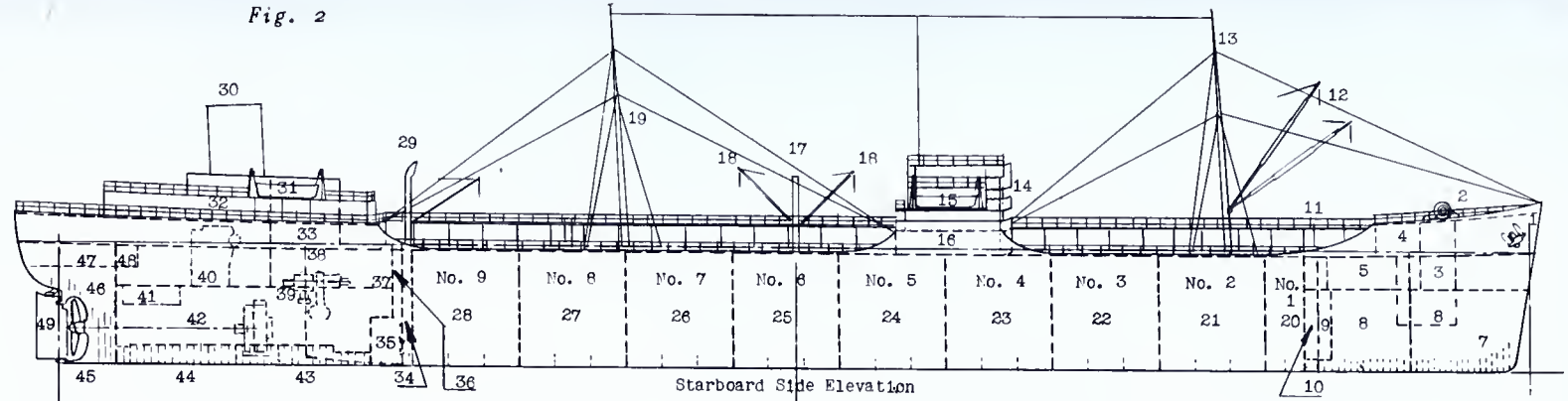
TERMS AND LOCATIONS

Ship's Anchor
Anchor Windlass
Chain Locker
Ammunition Trunk
Dry Cargo
Ammunition Chamber
Fore Peak Tank
Deep Tank
Pump Room Forward
Cofferdam
Walk Way or Cat Walk
Ship's Cargo Booms
Foremast
Navigating Bridge and Quarters for Officers
Life Boat
Fresh Water Tanks and Storage Place
King Post
Hose Boom (Booms for Lifting Hose to Make Fast--For Loading Cargo)
Main Mast
No. 1 Cargo Tank
No. 2 Cargo Tank
No. 3 Cargo Tank
No. 4 Cargo Tank
No. 5 Cargo Tank
No. 6 Cargo Tank
No. 7 Cargo Tank
No. 8 Cargo Tank

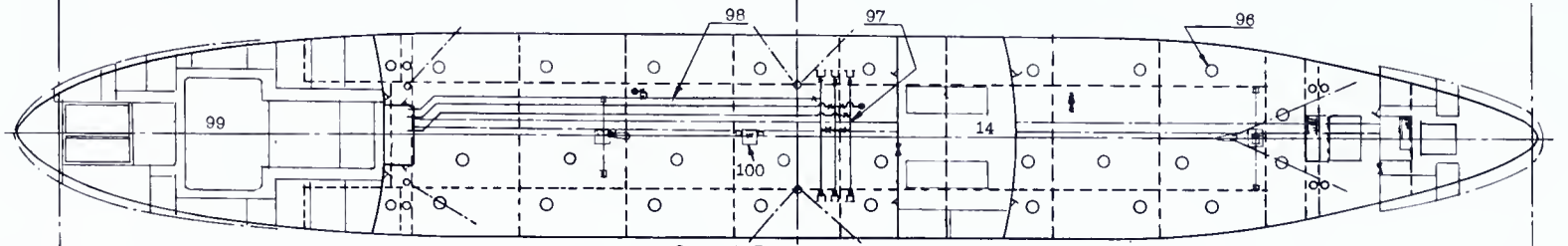
28. No. 9 Cargo Tank
29. Ventilator and King Post
30. Smoke Stack
31. Life Boats
32. Quarters for Officers
33. Quarters
34. Cofferdams at Sides
35. Cargo Pump-Room
36. Cargo Pump-Room Trunk
37. Fuel Oil Tanks
38. Turbo-Generator
39. Main Propulsion Motor
40. Boiler
41. Distilled Water Tank
42. Propeller Shaft
43. Feed Water Tanks or Double Bottom Tanks
44. Feed Water Tanks or Double Bottom Tanks
45. Propeller
46. After Peak Tank
47. Steering Gear
48. Fresh Water Tank
49. Rudder
50. Bosun's Stores
51. Chain Locker
52. Deep Tank and Dry Cargo
53. Forward Pump Room
54. Cargo Tank No. 1 Port
55. Cargo Tank No. 1 Starboard

56. Cargo Tank No. 2 Port Wing Tank
57. Cargo Tank No. 2 Center Port
58. Cargo Tank No. 2 Starboard Center
59. Cargo Tank No. 2 Starboard Wing Tank
60. Cargo Tank No. 3 Port Wing Tank
61. Cargo Tank No. 3 Center Port
62. Cargo Tank No. 3 Center Starboard
63. Cargo Tank No. 3 Starboard Wing Tank
64. Cargo Tank No. 4 Port Wing Tank
65. Cargo Tank No. 4 Center Port
66. Cargo Tank No. 4 Center Starboard
67. Cargo Tank No. 4 Starboard Wing Tank
68. Cargo Tank No. 5 Port Wing Tank
69. Cargo Tank No. 5 Center Port
70. Cargo Tank No. 5 Center Starboard
71. Cargo Tank No. 5 Starboard Wing Tank
72. Cargo Tank No. 6 Port Wing Tank
73. Cargo Tank No. 6 Center Port
74. Cargo Tank No. 6 Center Starboard
75. Cargo Tank No. 6 Starboard Wing Tank
76. Cargo Tank No. 7 Port Wing Tank
77. Cargo Tank No. 7 Center P
78. Cargo Tank No. 7 Center S board
79. Cargo Tank No. 7 Starbo Wing Tank
80. Cargo Tank No. 8 Port W Tank
81. Cargo Tank No. 8 Center I
82. Cargo Tank No. 8 Center S board
83. Cargo Tank No. 8 Starbo Wing Tank
84. Cargo Tank No. 9 Port W Tank
85. Cargo Tank No. 9 Center
86. Cargo Tank No. 9 Center S board
87. Cargo Tank No. 9 Starb Wing Tank
88. Fuel Oil Tank
89. Cofferdam
90. Cargo Pump Room
91. Cofferdam
92. Fuel Oil Tank
93. Engine Room
94. Shaft Alley and Machi Space
95. After Peak Tank
96. Cargo Hatch Covers
97. Heating Coils
98. Heating Coil Piping on Plate
99. Boiler Room
100. Deck Winch

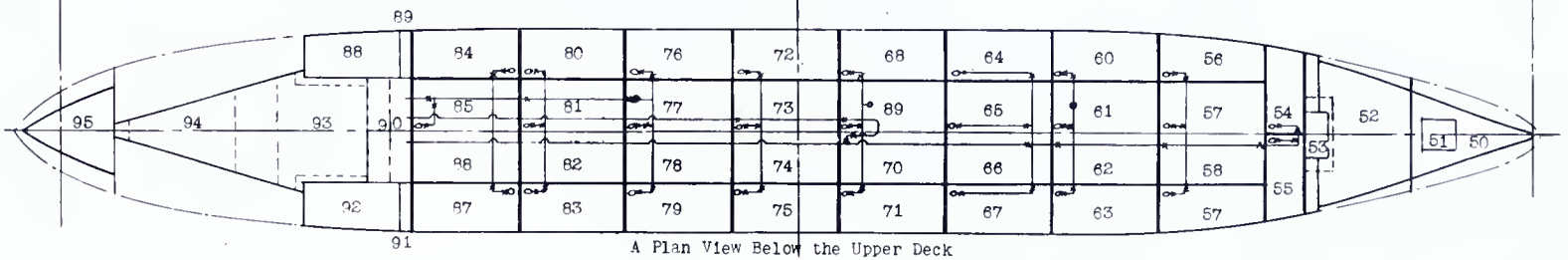
Fig. 2



Starboard Side Elevation



General Plan View of Ship



A Plan View Below the Upper Deck

QUESTIONS

1. Cargo tanks are numbered 1 to 9. Is No. 1 Cargo Tank forward or aft?
2. State the location of the cargo pump room.
3. Where are the fuel oil tanks located?
4. Is the main propulsion motor nearer to the bow or the stern of a tanker?
5. What is the purpose of the propeller shaft?
6. When facing the stern of a ship, is the port side on the right or on the left?
7. Explain the reason for the steering gear and give the location.
8. Where is the deep and dry cargo tank located?
9. Cargo tanks have port wing, center, and starboard wing divisions. Are these divisions separated from each other?
10. What jobs will be done by the outside machinist in the engine room?
11. Give the location of the engine room.
12. What is the name of the deck on which deck stands are installed?
13. Where are the cargo pump valves located?
14. What is meant by the cargo pump room trunk?

Mechanics' Scale

RULES AND SCALES

Several types of scales are used by outside machinists as they about their work. "Scale" is the term or name given to what a carpe ter calls a rule.

STANDARD MEASURE

In order for the outside machinist to have his work agree wi the blueprint he must follow the sizes given and measure from the ce ter lines or other points exactly as shown. He must use the same ty of measuring tool which was used by the draftsman. It follows, the

at all scales are STANDARD; that is, the length of one inch or one ot on one scale is the same length as one inch or one foot on another ale.

ALE DIVISIONS

When we examine a scale, we find there are many marks or fine its along the edge of the tool. These marks are for the purpose of viding the length of the scale into many equal parts. No matter w long the scale may be, each inch is found to be exactly the same ngth. If all the work to be measured was an exact number of whole ches in size, a scale divided into inches would serve the purpose. t this is not so.

EADING MEASUREMENTS

Measurements are given in feet and inches, or in feet, inches, d parts of an inch. For example: A certain piece of steel plate r steel strip, may be measured and the length found to be 2 feet, -1/2 inches; the width 1 foot, 2 inches; and the thickness 3/4 of e inch. Another way of saying the same thing would be: 2' 4-1/2" 1' 2" x 3/4". The x used here means "by". For example: 2" x 4" s read "two by four inches". Sizes are sometimes given in feet and nches, and sometimes the sizes are given in inches or parts of one nch.

EADING MEASUREMENTS CORRECTLY

A mechanic must be able to read a scale quickly or he is not a ood mechanic. He will lose a lot of time and cause others to lose ime unless he can read a scale correctly, at the first attempt. The echanic must thoroughly understand the markings on the scale before e can read it correctly.

NE INCH GRADUATIONS

Suppose we talk about a one-foot scale first. There are 12 inches in one foot; so a one-foot scale would have 12 equal spaces, but ot 12 marks or dividing lines. The lines mark off the spaces. The paces are called graduations. With a scale like this we could measre as close as one inch. See Fig. 3.

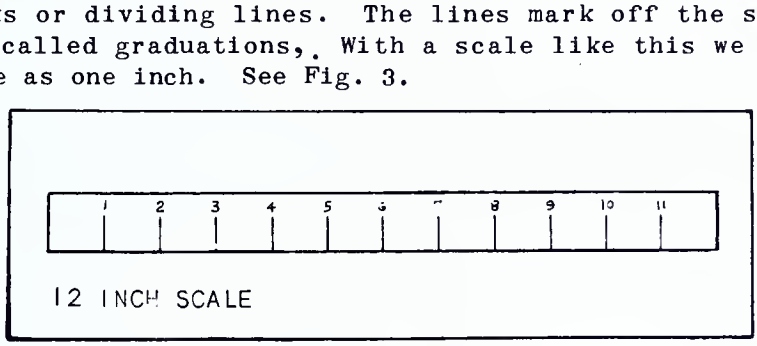


Fig. 3

The markings on the scale show one graduation or division which i this case is 1 inch. Of course this scale would do all right to measur *even* inches, but anything less than one inch could not be measured. T overcome this objection, each division or graduation is marked off i half-inches. See Fig. 4.

HALF-INCH GRADUATIONS

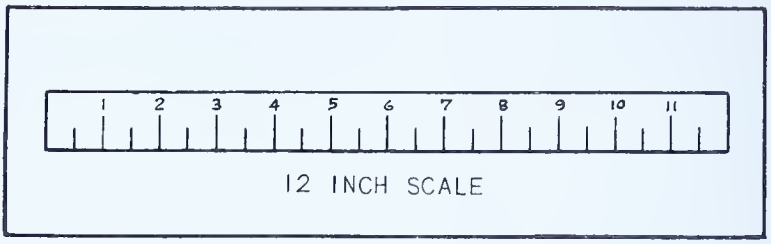


Fig. 4

Now the markings on the scale show two graduations or divisions the same length in one inch. The scale may be used to measure as clos as 1/2 inch. But the work has to be much closer than 1/2 inch. There fore, the graduations or divisions must be made still finer. Fig. shows about two inches of a mechanic's scale divided into very smal parts. Examine Fig. 5 carefully and it is plain that there are 6 spaces between the left-hand end of the scale and the mark numbered "1" Therefore, these graduations are each 1/64 of one inch long.

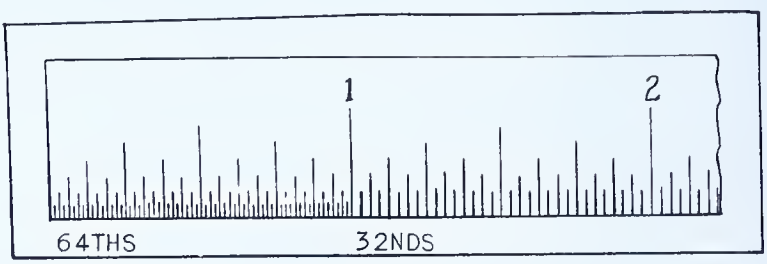


Fig. 5

The markings on the scale between the mark numbered "1" and th mark numbered "2" divide this inch into 32 parts. Therefore, thes graduations are each 1/32 of an inch long. At the same time, it plain that the longest marks divide the inch into halves, (1/2); th next longest marks divide the inch into quarters, (1/4); and so on do to the finest graduation.

GRADUATIONS IN ONE INCH

It should be clear that there are:

2 halves in one inch	- Read each division 1/2 inch
4 quarters in one inch	- Read each division 1/4 inch
8 eighths in one inch	- Read each division 1/8 inch
16 sixteenths in one inch	- Read each division 1/16 inch
32 thirty-seconds in one inch	- Read each division 1/32 inch
64 sixty-fourths in one inch	- Read each division 1/64 inch

Notice that each division or graduation is just half of the one fore and that the figure used to name the graduation is just twice large as the one before. The finest measurement that may be taken th a scale divided or graduated as above is 1/64 of an inch.

TYPES OF SCALES

There are several types or kinds of mechanics' scales. One scale dely used is a six-foot tape, made of steel ribbon. The steel ribbon about 1/4" to 3/4" wide and very thin. The steel ribbon is graduted as fine as 1/16" and rolls up into the casing. Some casings have spring inside to help in winding up the tape. See Fig. 6.

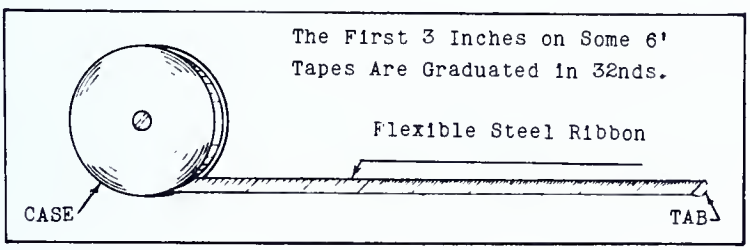


Fig. 6

USING THE TAB

A small tab is shown on the end of the tape in Figure 6. This ab may be hooked over the end or edge of a piece of material while he mechanic stretches the tape tightly. The reading is then taken. tape must never be allowed to "sag" or get slack when measuring the ork. Always take the measurement from the *inside* of the tab.

FIFTY-FOOT STEEL TAPE

Another type of steel tape is 50 feet long. Very long measurements are taken with a fifty-foot steel tape. These tapes must be used correctly or wrong measurements will result. On the end of the tape there is a loop of stiff wire. See Fig. 7.

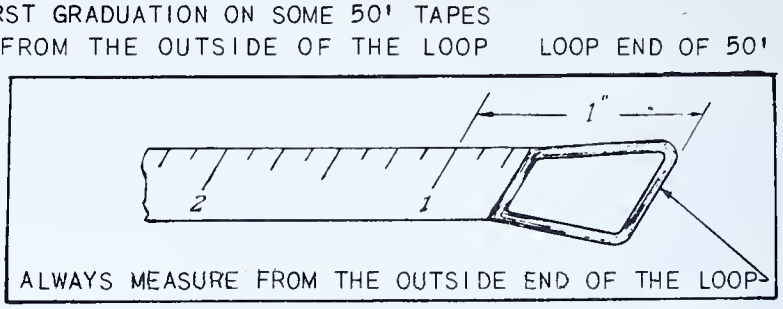

THE FIRST GRADUATION ON SOME 50' TAPES
IS 6" FROM THE OUTSIDE OF THE LOOP
LOOP END OF 50' STEEL TA
1"
2
1
ALWAYS MEASURE FROM THE OUTSIDE END OF THE LOOP

Fig. 7

CAUTION

Notice that it is *one inch* from the outside end of the loop to t Figure "1" on the tape. This loop prevents the tape from being lost the casing when the mechanic winds it up after using. Always measu from the outside end of the loop. Do not allow the loop to become fo ded over or under.

All steel tapes used where accuracy is required should be check frequently with the tape belonging to an official of the company a kept by him for this purpose. Some mechanics check their tapes twice week on regular days, Monday and Thursday, before starting work on the days. To make the check, reel out the official's tape far enough check the total footage marked on the tape to be used on a specific jo Run out the tape to be checked, place the zero of each tape even, a check the highest foot mark on the tape with that foot mark on the o ficial's tape. If they correspond exactly, the tape checked may be p into use. If there is any discrepancy at the highest foot mark, do r use this tape for accurate work.

In using a steel tape always keep it straight. Never hold it lay it down in such a way that it will kink. A kinked tape is inacc rate and will soon break.

In placing the one-foot mark on a point, the *center* of the sca mark must be put exactly on the point.

Never walk on a tape or drop anything on it, because it is a fra ile, sensitive tool.

When measurements are to be taken that will necessitate unreeli the full length of the tape, unreel the full length and carefully l the tape alongside the line on the floor where measurements are to made. Stand the reel or case up on the floor to keep all of the ta right up to the case perfectly flat.

If a tape is to be left any length of time stretched out on t floor, lay template boards close up to the tape for the full length the stretched-out portion. The edge of the template board will prev

yone from actually stepping on the tape. A shoe will clear the tape cause of the thickness of the edge of the template board, forcing the oe to "bridge" over the tape lying alongside.

To pull a steel tape to get slack out of it, place the thumb on top it and fingers of the same hand under the tape and pull. *Do not press e thumb to the floor.* To do so will make a sharp bend in the tape back the thumb and may permanently damage the tape by kinking it. Pull e tape at a point 12 inches beyond a mark, and press the tape to the oor at the mark which will be 12 inches from the thumb and fingers lling the tape, and no possible kink can result. See Fig. 8.

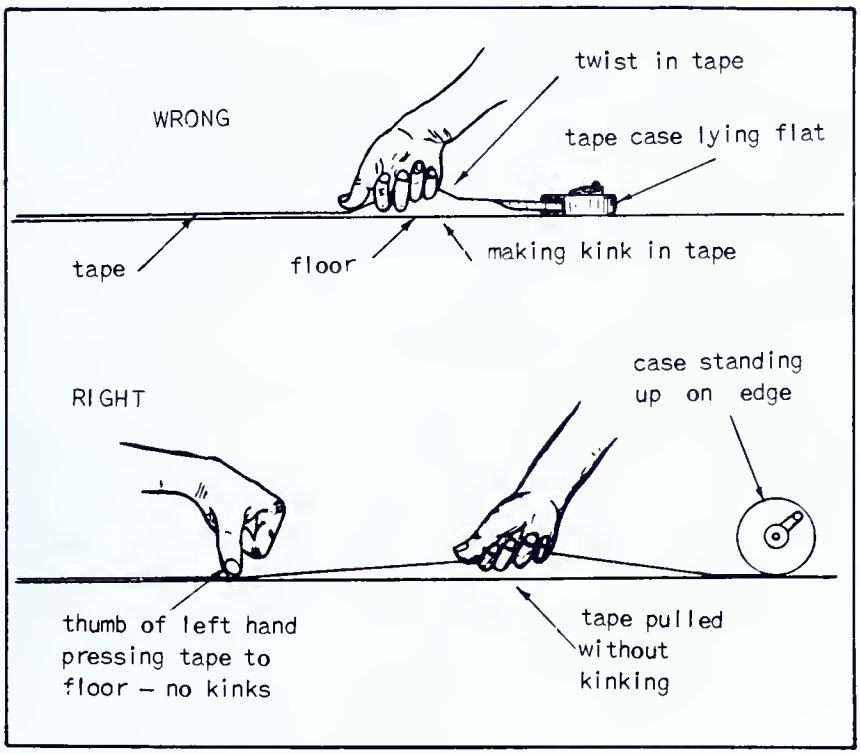


Fig. 8

LDING RULE

Six-foot folding rules, either metal wood, are often used to advantage. th care, very close measurements may be ken. The rule folds up into 12 sections ich makes a small bundle about 7-1/2 ines long, 3-1/2 to 3 inches wide, and ssibly 3/4 inches thick, depending on e width of the rule.

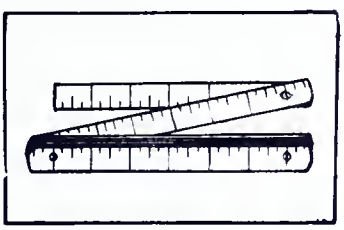


Fig. 9

ECIAL FEATURES

This is a very handy rule for several reasons: The rule may e adjusted at the joints to form an angle; the rule may be pushed up as gh as a man can reach, straight overhead without buckle; or it may be

supported at two points along the length while the mechanic steps ba to take a sight on some part of the work, when working alone.

ACCURACY OF THE FOLDING RULE

A folding rule is not so accurate as a steel tape, for when t rule becomes worn at the joints, a difference of as much as 3/16 of inch error is possible in six feet, owing to the looseness of the joint Therefore, a steel tape is always the better to use when accurate mea urements are to be taken. Six-foot rules are graduated to 1/16 of inch. From this fact it is clear that this type of rule was not inte ded for very close measuring.

THE SIX-INCH STEEL SCALE

Many jobs require the use of a six-inch steel scale. These scales are graduated to 64ths of an inch and are used when measuring for "chock-fitting", checking diameters of holes and shafting, and other fine measuring work. The chock-fitter also uses a six-inch scale as a straight-edge when testing small chocks for a level surface. See Fig. 10. When mea uring for chocks, all sizes are given to the shop in 64ths.

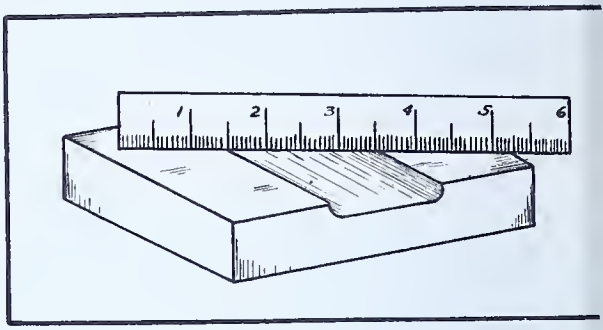


Fig. 10

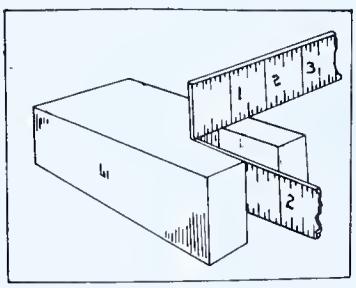


Fig. 11

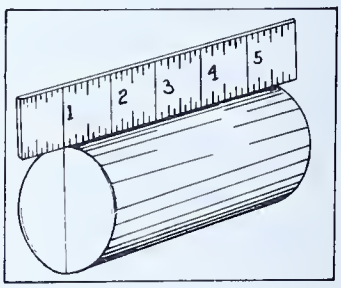


Fig. 12

Measuring the depth and width of a slot. The slot is $\frac{3}{4}$" wide. Hold the scale square with the surface from which the measurement is taken.

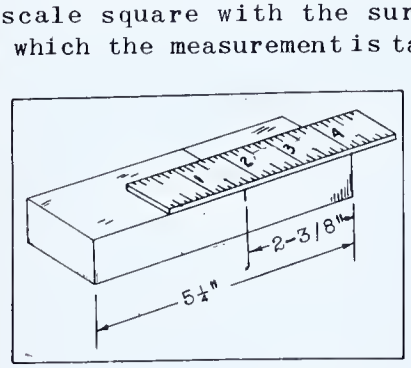


Fig. 13

Lay the scale parallel with t center line of the piece. Th cylinder is 4-5/8" long. Noti when the 1" graduation is placed the end of the piece the dimens reads 1" less than shown at t other end of the scale.

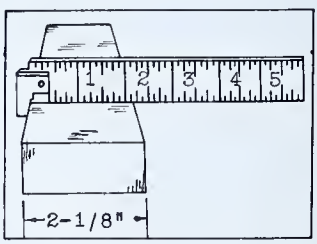


Fig. 14

e index mark on the scale, in is case the 4" mark (Fig. 13), is ned up exactly with the end of e piece. The mark on the work is und to be 1-5/8" from the other d of the scale. Subtracting 5/8" from 4" leaves 2-3/8". It ould be clear from this that it not necessary to have the 1" aduation at the starting point. y graduation may be used.

A hook rule or scale (Fig. 14) is a very convenient tool to use for quick, accurate measuring. The inside edge of the hook is exactly even with the end of the scale. Always hold the scale exactly square across the work. Allowing the scale to "slant" across the work will result in costly errors.

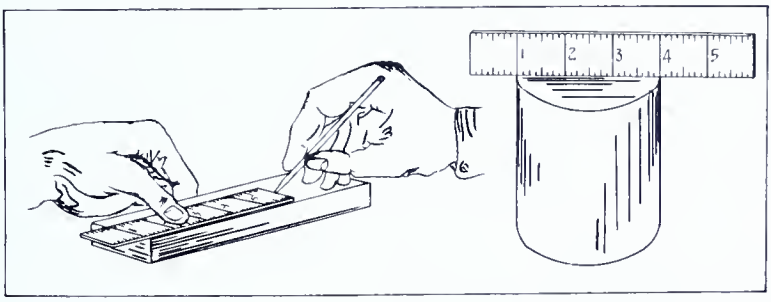


Fig. 15

Fig. 16

Hold the scale firmly with one hand while marking with the scriber ld in the other hand. See Fig. 15. If the scale slips, chalk the surce of the work and begin all over. One line is enough. Two or more nes only confuse the mechanic.

When measuring the diameter of a cylinder, measure exactly across e center of the cylinder to avoid error. See Fig. 16. Where this nnot be done use calipers. See Fig. 23, Calipers, Dividers, etc.

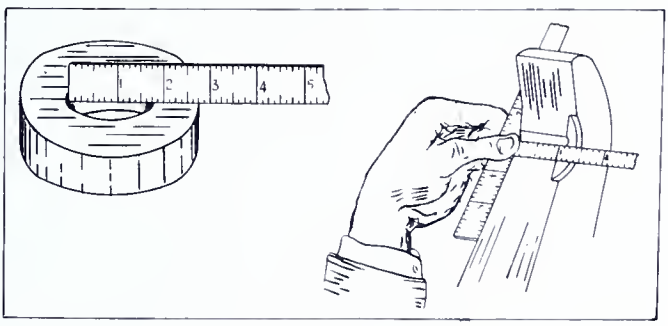


Fig. 17

Fig. 18

When measuring the diameter of a hole, measure exactly across the enter of the hole. Tilt the scale just enough to catch against the ide of the hole. Swing the scale back and forth just enough to make ure to measure the full diameter. See Fig. 17.

When measuring the thickness of an irregular piece, hold the scale arallel with the center line of the hole. Use another scale in the eft hand as a stop from which to measure. See Fig. 18. A hook rule ould be used on this job to good advantage.

QUESTIONS

1. Explain the purpose of the marks on a mechanic's scale.

2. Which is the graduation: The mark? or the space between the marks?

3. Are all sides of a scale graduated in quarter inches?

4. When measuring with a six-foot tape, is the measurement taken from the outside or inside of the tab?

5. When measuring with a 50' tape, is the measurement taken from the outside or inside of the wire loop?

6. What are the finest graduations on a six-inch scale?

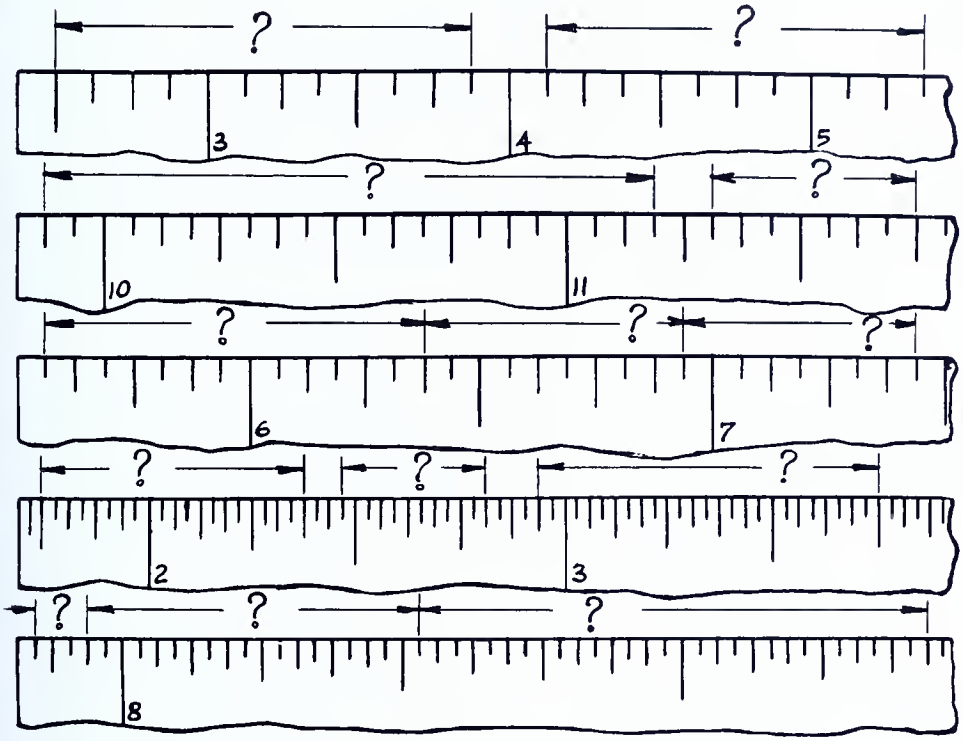
7. Name one or two places where the six-inch scale may be used as a straight edge.

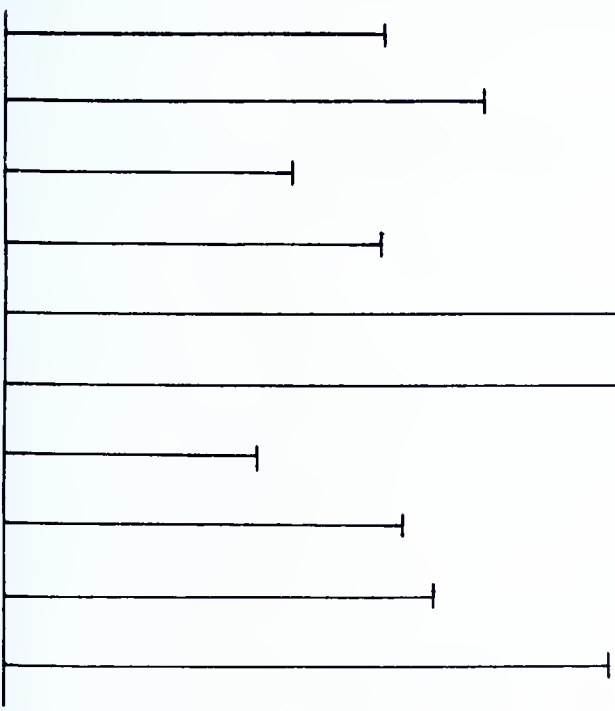
8. Explain the advantages and disadvantages of a folding rule.

9. What precautions should be taken when measuring with a fifty-foot steel tape?

10. Is it better to measure from the end of a scale or from a graduation mark when taking a close measurement? Why?

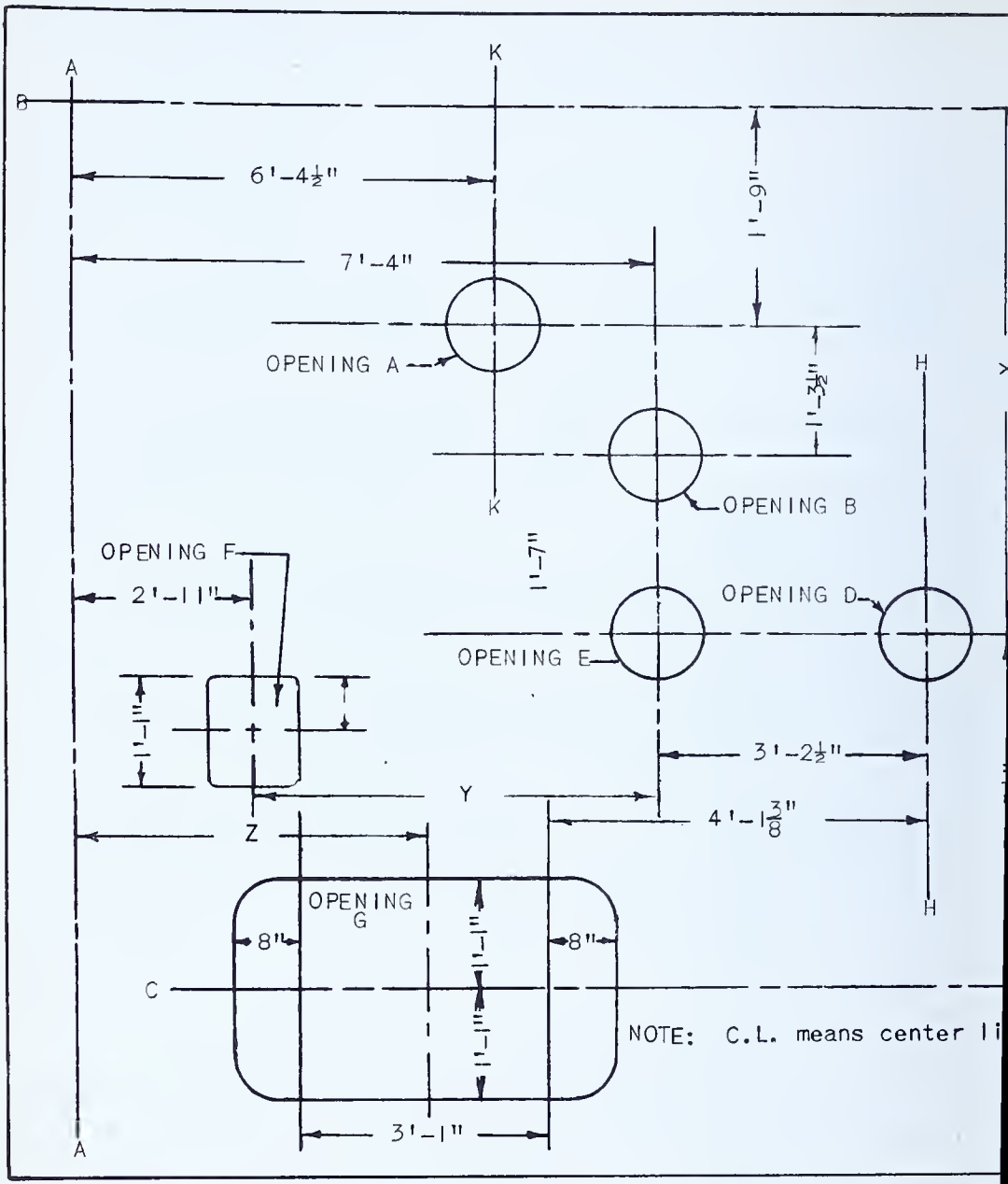
The distances between the arrows are to be measured. DO NOT USE A SCALE TO MEASURE.





Measure, with a scale, the lengths of these lines from the long line to the short line.

ALL CENTER LINES ARE IN THE CENTERS OF OPENINGS



1. What is distance "X"? 2. How long is opening
2. What is the total width of opening "G"? 4. What is distance
5. Give the distance from C.L. "A-A" to C.L. "H-H".
6. What is the vertical distance from center of opening "A" to ce of opening "D"?
7. State the horizontal distance from C.L. "K-K" to C.L. "H-H".
8. What is the distance from C.L. "B-B" to C.L. "C-C"?
9. How much does distance "Z" measure?
10. Measure distance from C.L. "C-C" to center of opening "A".

Calipers, Dividers, and Morphs

POSE OF CALIPERS

Diameters of shafting, sleeves, holes in couplings; the thick-s of plates; sizes of rods and distances between faces, have to easured very accurately. These items just mentioned have to fit r parts when installations are made throughout the ship.

G CALIPERS AND A SCALE

It is impossible to measure these sizes accurately by using on- a scale. The machinist uses a tool called a caliper to obtain the e or distance and then places the caliper on the scale to read the surement. Illustrations of the use of calipers are shown on suc- ling pages.

E OF CALIPERS

Calipers should not be allowed to get rusty. A little oil or ing with an oily rag will prevent rust. Never use a caliper rough- Allowing calipers to be thrown around or to become mixed up with ts and other material on the job will destroy their accuracy.

D OF CALIPERS

There are two kinds of calipers: Outside calipers and inside cali- s. See Figs. 19 and 20.

CIFIC USE OF INSIDE CALIPERS

Inside calipers are used to measure inside diameters of holes or distance between two faces or surfaces. See Figs. 21 and 22. It is ortant to keep the caliper at right angles with the work.

CIFIC USE OF OUTSIDE CALIPERS

Outside calipers are used to measure the diameters of shafting, linders, the thickness of plates, the diameters of bolts, and the stances from outside to outside of two surfaces. See Figs. 19, 23, 24.

NSTRUCTION OF CALIPERS

Calipers are made with a "firm joint" or with a "C" spring joint. e Figs. 19 and 25.

ECKING OUTSIDE DIAMETERS CORRECTLY

Measuring the outside diameter of a shaft or a bolt is a common use r outside calipers. The procedure is as follows: Hold the work, or ece to be measured, in the left hand and adjust the calipers with the ght hand until the caliper points will just pass over the work with a ight "feel". The instructor will demonstrate how this feel is obtained.

When the work is too heavy to hold in the hand, make sure the caliper sses a short distance beyond the center of the work. For accurate re- lts, the caliper must be held at right angles or square with the center ne of the piece being measured. See Figs. 19 and 23.

"SETTING" THE CALIPERS

The process of adjusting the calipers to the work is called "setti the calipers"; and after the adjustment has been completed, the calip is said to be "set". Never pick up a pair of calipers and change t "set" without first finding out if it is all right to do so. Someo else may be using that setting for some important measuring which w hard to get.

CHECKING INSIDE DIAMETER WITH OUTSIDE DIAMETER

Sometimes it becomes necessary to find out if a certain shaft wi fit a hole in a piece of work. If the job is small enough to carry arou easily, it is a simple matter to pick the shaft up and try it in the hol Many pieces, however, are too heavy to do this; it is then necessary measure the hole, or the shaft, with the right caliper and then set t other caliper to the first caliper used. See Fig. 26.

POCKET SLIDE CALIPER

A very convenient form of caliper is the pocket slide caliper. S Fig. 27.

These slide calipers come in two sizes, 3-inch and 5-inch. T three-inch size has a capacity for measuring inside or outside diamete up to 2 inches. The five-inch size has a capacity for measuring insi or outside diameters up to $3\frac{1}{2}$ inches. There are two register marks the sliding part of the caliper. One mark is used when measuring insi diameters, and the other mark is used when measuring outside diameter A convenient lock nut may be tightened to hold the setting. The appro imate diameter of the work may be read without removing the slide cal per.

HERMAPHRODITE CALIPERS

Hermaphrodite calipers, commonly called "Morphs", are used pri cipally for scribing lines parallel with surfaces or edges. The poin are hardened and may be adjusted up or down for the best results. S Fig. 28.

DIVIDERS

Dividers are made in many sizes and in many styles. The Yank pattern divider, shown in Fig. 29, is most commonly used. The poin are hardened and great care must be taken not to break these importa parts of the divider. Close work cannot be done with a stubby divi point.

Dividers are used to make circles, find centers of circles, fi centers of broken bolts, divide distances into equal spaces, and oth such operations. Lay the dividers down as flat as possible when se ting them to scale dimensions. This saves the points, and greater a curacy is possible. See Fig. 30.

QUESTIONS

1. Why is a caliper used to measure instead of measuring with a scale?

2. Explain the reason for having inside and outside calipers. Why have two kinds?
3. State the purpose of an hermaphrodite caliper. (Morphs.)
4. What may be the result if the "setting" of calipers or dividers is changed before finding out if someone is using the tool?
5. Which tool is used to make a circle?
6. Explain why it is necessary to keep divider points sharp.
7. Which tool is used to scribe a line parallel to an edge or surface?
8. In measuring the diameter of a hole which caliper is used?

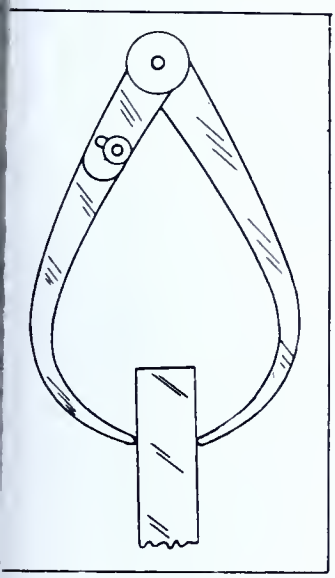


Fig. 19 - Lock-Joint Outside Calipers

Measuring the thickness of a piece of steel plate. When the calipers are set, find the scale reading as shown by Fig. 24.

Measuring the distance between two faces.

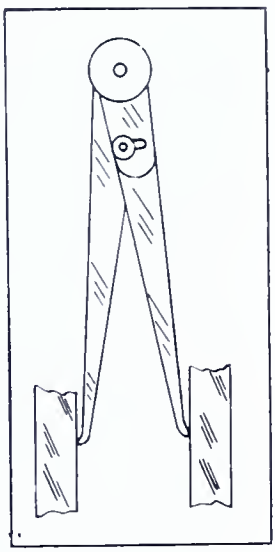


Fig. 20 - Lock-Joint Inside Calipers

ing inside calipers to measure e distance between two plates ıch as a machine base and a undation. The distance is und by trying the calipers on scale after measuring. The structor will demonstrate the rrect way to place the calipers on the scale.

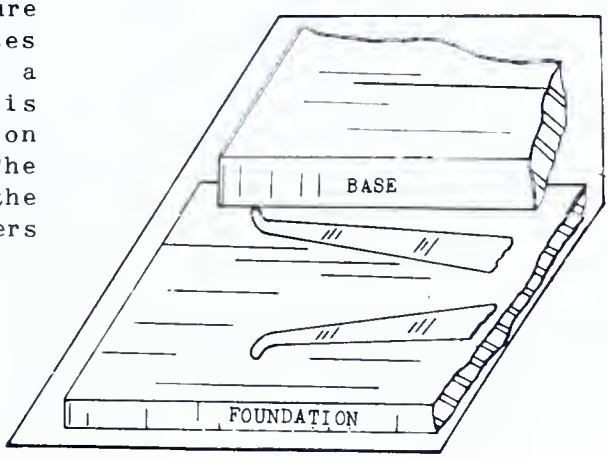


Fig. 21

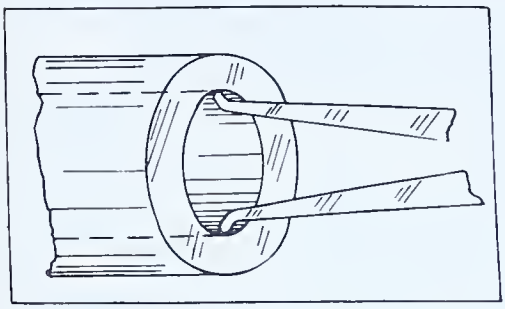


Fig. 22

Using inside calipers to find t
inside diameter of a hole. Keep t
calipers square with the cent
line. The instructor will demo
strate the correct method of "swir
ing" the calipers to get the exa
diameter.

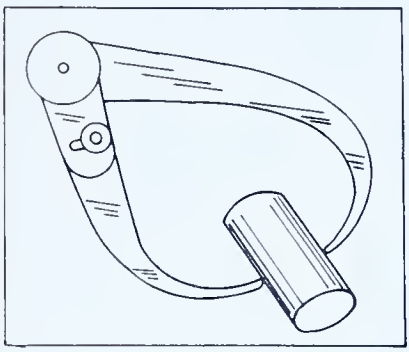


Fig 23

Pass the calipers back and forth over the shaft until the points just touch. Keep the calipers square with the center line. The instructor will demonstrate this.

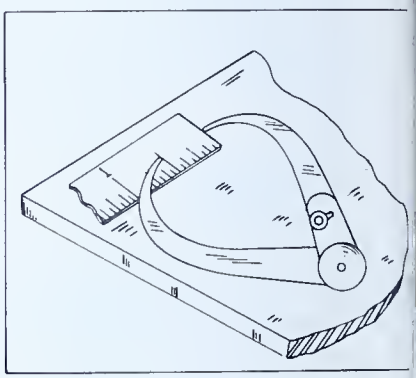


Fig. 24

One point of the calipe
should always be held agair
the end of the scale as shov
Never try to check a size y
having both points on te
scale.

The length of a caliper or divider is always measured as as shown in Fig. 25.

These calipers are adjusted with a screw and thumb nut. Inside calipers are made of the same type. The "C" spring keeps the caliper at the "open" position.

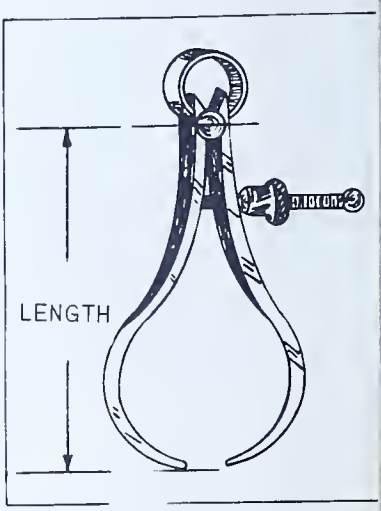


Fig. 25

ky the caliper points flat
a table, plate, or bench
nen setting one to the other.
bing this keeps the points
line for an accurate meas-
urement.

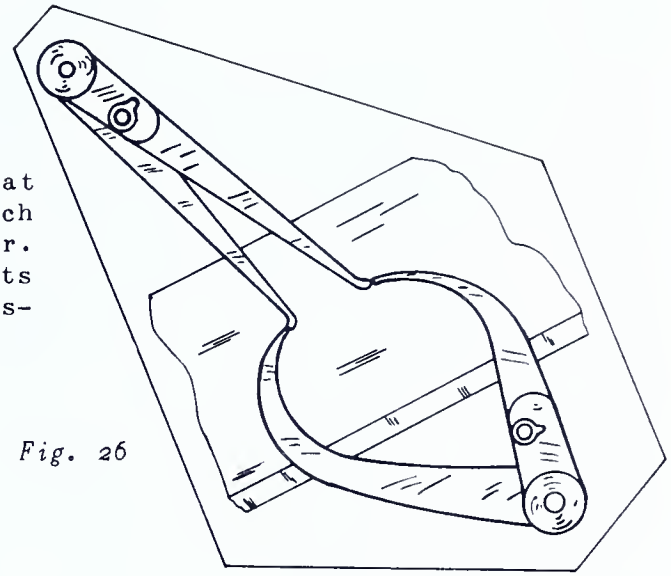


Fig. 26

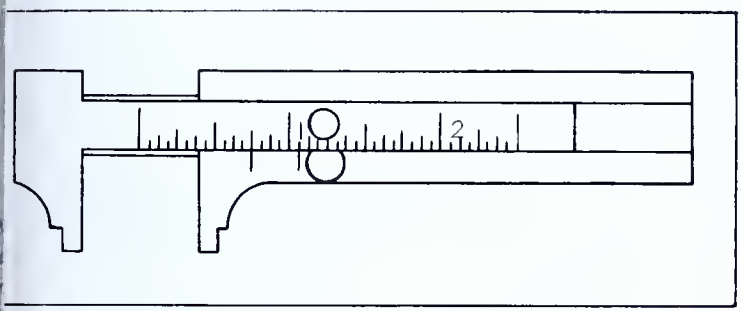


Fig. 27 - Pocket Slide Caliper

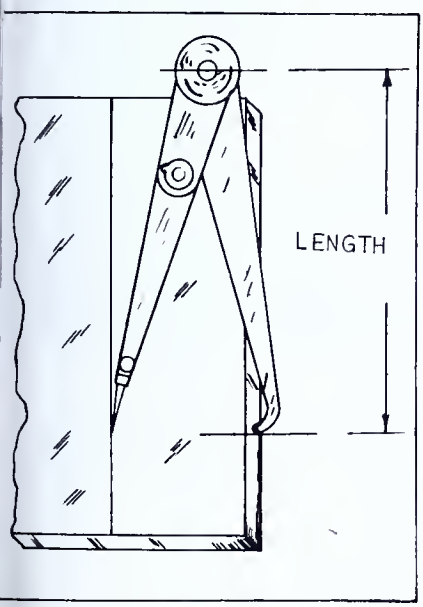


Fig. 28 - Lock-Joint Hermaphrodite

The pocket slide caliper is a very useful tool for getting approximate sizes quickly, either inside or outside diameters. The tool in the illustration is set at 3/4" opening. Note the register mark on the body of the slide. The register mark at the right is for inside diameters.

Scribing a line parallel with the edge of the work.

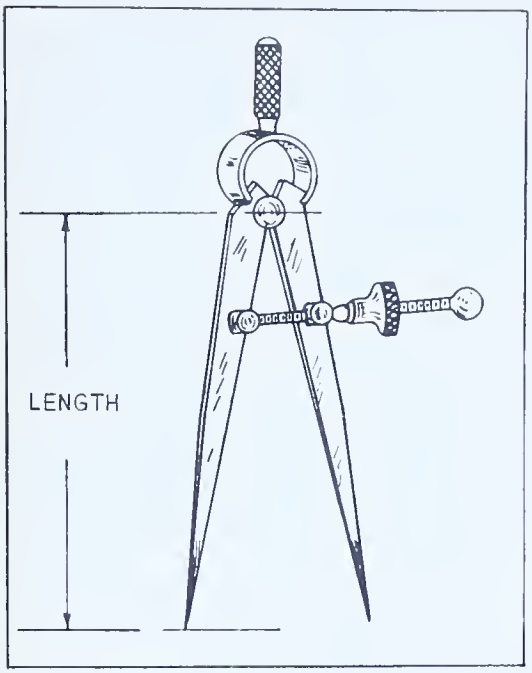


Fig. 29 - Typical "Yankee" Pattern, Spring Dividers

Hardened points, screw adjustment. Dividers with dull or broken points are useless.

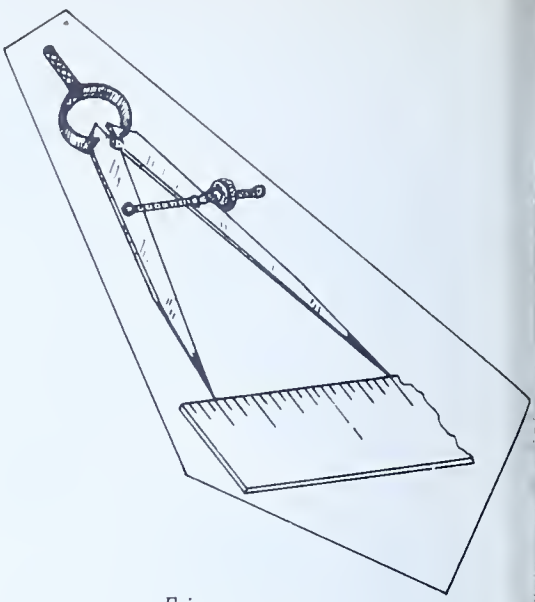


Fig. 30

Fig. 30 shows dividers set to 1-1/4 on the scale. Always lay the divi ders down flat, with the points i a graduation mark. Doing this wil protect the points from bein dulled, and a closer setting may b obtained because a clear view ma be had of the scale and divide points.

Reading the Micrometer

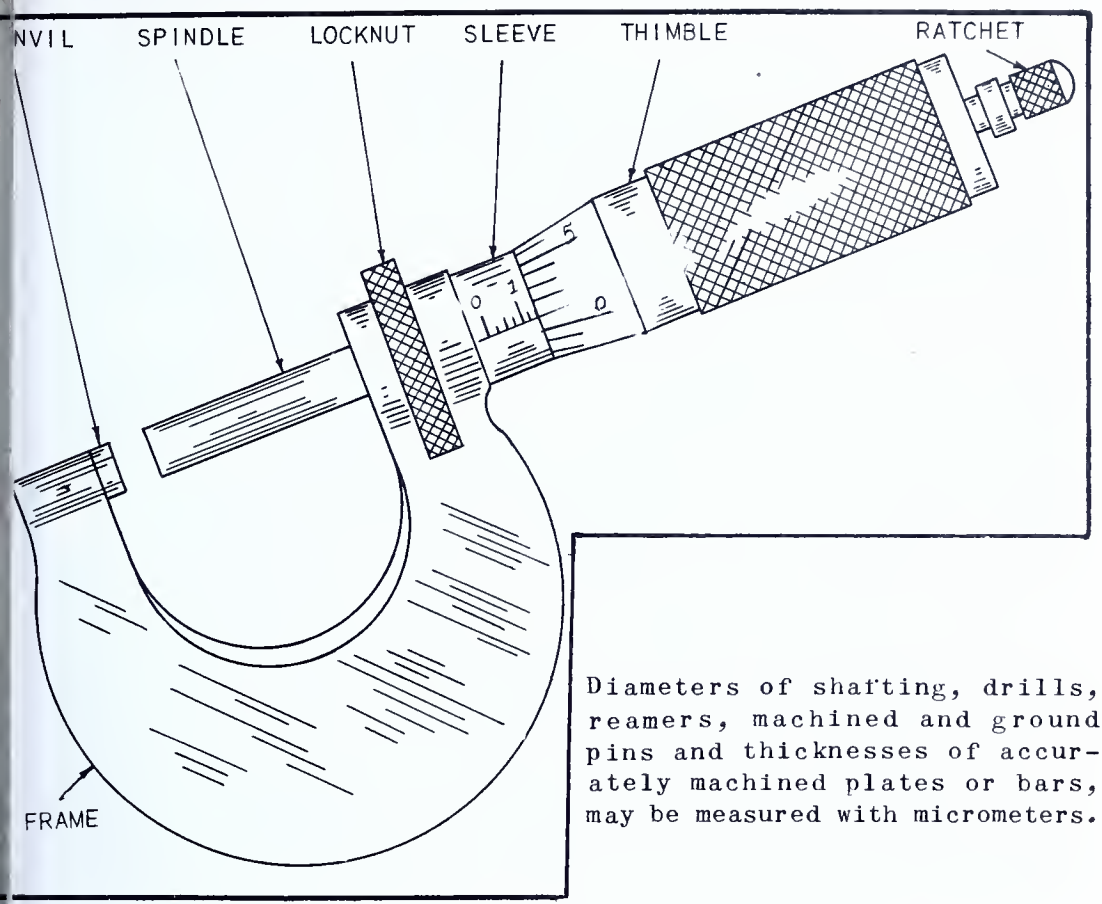
PURPOSE OF MICROMETERS

The ordinary type of mechanics' scale is graduated as fine a 64ths of an inch only. Many measurements must be taken which are muc finer than this. Such measurements are so fine that it would be im possible to engrave the dimensions on a scale so they could be reac The tool which is used to do this fine measuring is called a micrometer and it is possible to measure sizes to .0001 of an inch. Fig. 31 illus trates the general construction of an outside micrometer and gives th names of the principal parts.

OUTSIDE MICROMETERS are used to measure outside diameters an thicknesses. INSIDE MICROMETERS are used to measure inside diameters the distance between surfaces, and other similar dimensions.

CAPACITY OF MICROMETERS

Micrometers are listed according to the measuring capacity. Se Starretts catalog No. 26, pages 97-139, for complete details.



Diameters of shafting, drills, reamers, machined and ground pins and thicknesses of accurately machined plates or bars, may be measured with micrometers.

Fig. 31

When speaking of a one-inch micrometer it is understood that any measurement from nothing up to and including 1 inch may be taken. A two-inch micrometer measures distances from 1 inch up to and including 2 inches; a three-inch micrometer is used for jobs from 2 inches up to and including 3 inches, and so on.

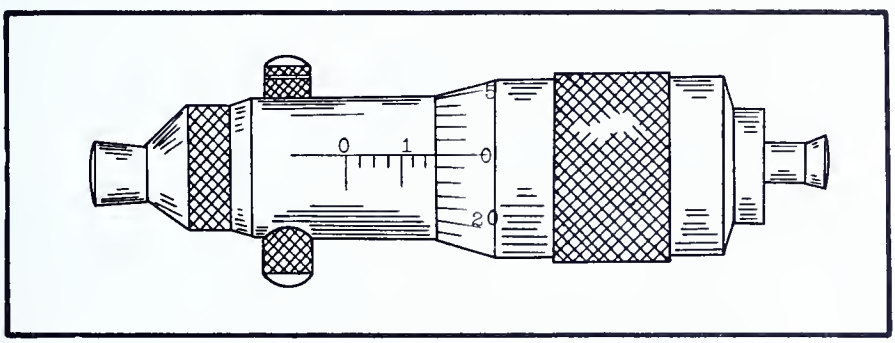


Fig. 32 - Inside Micrometer

Inside micrometers, see Fig. 32, are equipped with extension pieces called rods and a handle for getting the tool into narrow places. The instructor will demonstrate the use and handling of micrometers.

READING A MICROMETER

Outside or inside micrometers are read exactly the same way. Fi 33 shows the thimble set to zero on the sleeve. One full turn of the thimble opens the gap between the anvil and the spindle nose exactly .025 of an inch (twenty-five thousandths). It should be quite clear that if the thimble is given four full turns the gap between the spindle nose and the anvil will be .100 of an inch, (one hundred thousandths) or .1 of an inch (one-tenth). Notice the figure 1 on the sleeve. The figures on the sleeve indicate tenths of an inch or hundred thousandths.

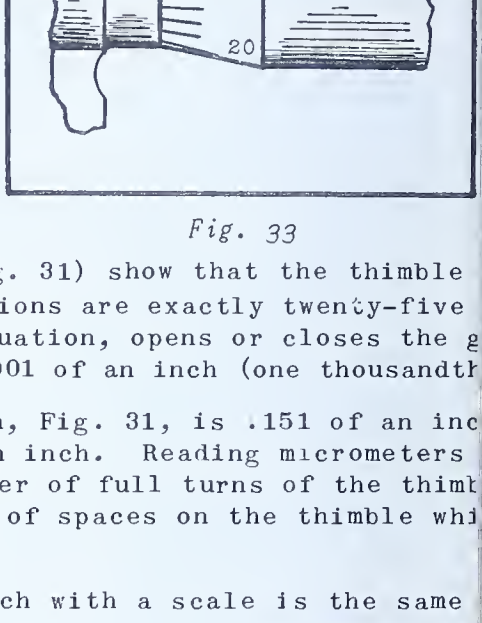


Fig. 33

The figures on the thimble (Fig. 31) show that the thimble graduated all around. These graduations are exactly twenty-five number. Moving the thimble one graduation, opens or closes the g between the anvil and spindle nose .001 of an inch (one thousandth

The setting on the illustration, Fig. 31, is .151 of an inc On Fig. 32 the setting is .175 of an inch. Reading micrometers simply a matter of counting the number of full turns of the thimb on the sleeve and adding the number of spaces on the thimble whi have passed the zero mark.

For example: Measuring 1/8 inch with a scale is the same .125 when measuring with micrometers, except that the micrometer me urement is much closer.

The decimal equivalent table, Page 33, illustrates how easy it to select the correct decimal for any fraction found on a mechani scale.

ADDING AND SUBTRACTING

When adding 3-1/2, 2-1/4, 4-11/16, 9-5/16, 2-3/16, 1-9/64, it much easier, quicker, and more accurate if done this way:

3.5
2.25
4.6875
9.3125
2.1875
1.140625
23.078125 or 23-5/64

Always be sure to have the decimal points directly in a vertical line, and check the addition from top to bottom after adding.

The value of .078125 is found in the table of decimal equivale The total distance may now be laid off with a common mechanic's sc After a little practice the mechanic will have memorized many of decimals and will not need to refer too frequently to the table. any event the decimal equivalent of the fraction can be found by viding the number above the line by the number below the line.

When called upon to subtract 9-11/64 from 15-15/16 it is much easier to say 9.171875 from 15.9375 is:

15.9375
Minus 9.171875
6.765625 or 6-49/64

MULTIPLICATION

When it becomes necessary to multiply 9-11/64 by 15-15/16, the calculation is much easier if decimals are used. For example:

(a) 9.171875 x 15.9375

There are as many decimal places in the product of the two numbers as the total number of places in both numbers.

```
  9.171875
    15.9375
  45859375
 64203125
 27515625
 8 2546875
 45859375
  9171875
146.1767578125
```

Place one number under the other, disregarding the position of the decimal points.

(b) Multiply .037 by .006

```
  .037
  .006
 .000222
```

There were only three figures in the answer until three zeros were placed in front of the three twos. This is always done when there are not sufficient figures in the answer to make up the total number of decimal places in the two numbers being multiplied. Always place the zeros before the number. The above result is read: Two hundred twenty two millionths. An easy way to read a decimal is to write the decimal as follows:

.000,222

Extend the decimal point below the line making it into a figure 1 as follows:

.000,222
1

Then add as many zeros after the one as there are figures to the right of the decimal point above the line as follows:

.000,222
1000,000

DIVISION

The division of decimals is sometimes more difficult than addition, subtraction, or multiplication. The placing of the decimal point in the answer is very important. A few examples of placing the decimal point correctly are given below.

Example A:

Divide 2.50 by 1.25 . Move the decimal point to the right, two places, making both numbers whole numbers. Then 125., "goes into" 250., twice.

Example B:

Divide 1.25 by 2.50 . Move the decimal points to the right, two places, making both numbers whole numbers. Then 250 will not "go into" 125. Add a cipher making 125. read 125.0 . Now 250. will "go

into" 125.0 , 5 times. But since there was one decimal place in th dividend and no decimal places in the divisor, there will be one dec imal place in the quotient, or .5 .

Rules for Placing the Decimal Point

The examples given above show that the following rules must b observed:

Rule 1. Move the decimal point to the right in both divisor an dividend the same number of places, in order to change the decimals t whole numbers. Add zeros to the right, in the dividend, to balanc the first result by multiplication.

USING RULE 1

	Divisor	Dividend	Quotient
	1.25)	2.50	(_____

(a) Move decimal point to the right, the same number of place in the divisor and in the dividend.

125.)	250.	(2._____
	250	

Since there are no decimal places in the divisor or dividend, ther are none in the quotient.

(b)	1.25)	.25	(_____

Move decimal points to the right, the same number of places i the divisor and in the dividend. A zero is added to the right, in th dividend, to balance the result by multiplication.

125.)	25.0	(.2_____
	25.0	

Rule II. Point off the same number of decimal places in the quo tient as the places in the dividend exceed the places in the divisor.

USING RULE II

The decimal point in the quotient in example "b" is placed b using Rule II. Since there were no decimal places in the divisor an there was one place in the dividend, the places in the dividend exce the places in the divisor by one. Therefore point off one place i the quotient. The result is .2 .

Rule III. When there are more decimal places in the divisor th in the dividend, add zeros after the last figure in the dividend unt the decimal places in the dividend equal those in the divisor. Th proceed as in ordinary division.

NOTE: Add more zeros to the dividend if necessary. Adding zer to the last figure in the decimal, to the right of the de imal point, in no way alters the value of the decimal. check the result after dividing a number having decima by a number which has more decimal places than the numb being divided, inspect all of the numbers carefully. T answer should be pointed off to show the number in the qu

tient to contain as many whole numbers as the number of places in the divisor exceeds the number of places in the dividend, plus one.

For example: 672. ÷ .336 = 2000.

There are three decimal places in the divisor.
There are no decimal places in the dividend.
The decimal places in the divisor exceed the decimal places in the dividend by three.
Three plus one (3 + 1) = 4.
There will be four whole numbers in the answer.

Use Rule I, "a" and the problem is 672000. divided by 336. Dividing, we find the result to be 2000.

To double check any division, multiply the divisor by the quotient. The answer should be the same as the dividend, within a few thousandths.

SING RULE III

When the divisor contains all decimals:

.25 250. (_____

Move decimal points to the right, the same number of places in divisor and dividend.

.25) 25000. (_____
25

It was necessary to add two zeros to 250. before the decimal point ould be moved two places to the right. When this was done, the problem then was to divide 25000. by 25.

ROBLEMS

Use a separate sheet of paper. Find the answers to the following roblems:

Multiply:	1.	3-7/16 by .1875	3.	17.0032 by .0625
	2.	9.25 by 1.375	4.	.0073 by 1/4
Divide:	5.	.375 by .1875	7.	3.1416 by .7854
	6.	1.9375 by .875	8.	2-1/2 by 1.414

IRCUMFERENCE

The distance around the circumference s Pï times the diameter. hat is the diameter of a circle, the circumference of which is 6.2832?

IAGONAL

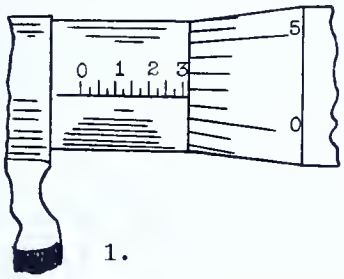
The distance across the corners of a square is 1.414 times the ength of one side of a square.

Find the length of one side of a square when the distance across he corners is 4.2426.

Decimal Equivalents of a Fraction of an Inch

1/64	.015625	11/32	.34375	43/64	.671875
1/32	.03125	23/64	.359375	11/16	.6875
3/64	.046875	3/8	.3750	45/64	.703125
1/16	.0625	25/64	.390625	23/32	.71875
5/64	.078125	13/32	.40625	47/64	.734375
3/32	.09375	27/64	.421875	3/4	.7500
7/64	.109375	7/16	.4375	49/64	.765625
1/8	.1250	29/64	.453125	25/32	.78125
9/64	.140625	15/32	.46875	51/64	.796875
5/32	.15625	31/64	.484375	13/16	.8125
11/64	.171875	1/2	.5000	53/64	.828125
3/16	.1875	33/64	.515625	27/32	.84375
13/64	.203125	17/32	.53125	55/64	.859375
7/32	.21875	35/64	.546875	7/8	.8750
15/64	.234375	9/16	.5625	57/64	.890625
1/4	.2500	37/64	.578125	29/32	.90625
17/64	.265625	19/32	.59375	59/64	.921875
9/32	.28125	39/64	.609375	15/16	.9375
19/64	.296875	5/8	.6250	61/64	.953125
5/16	.3125	41/64	.640625	31/32	.96875
21/64	.328125	21/32	.65625	63/64	.984375
				1	1.0000

Several micrometer settings are given on this page. Read each setting to the nearest .0005.



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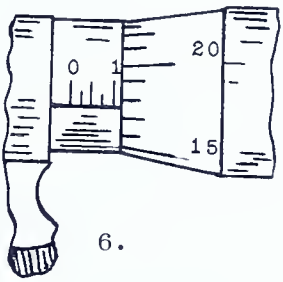

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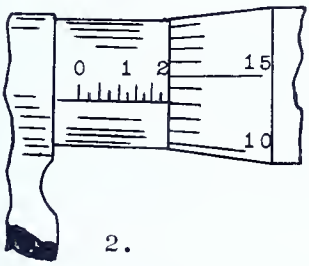

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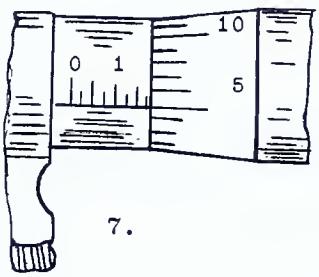

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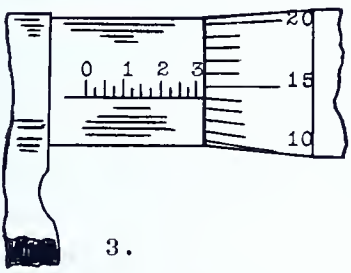

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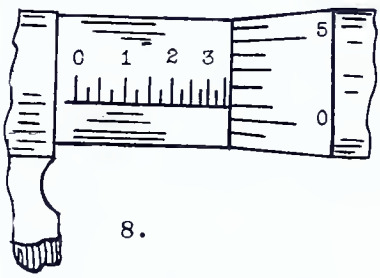

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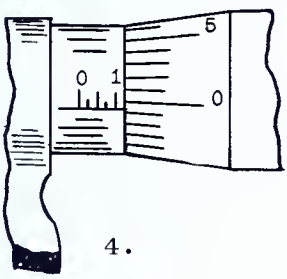

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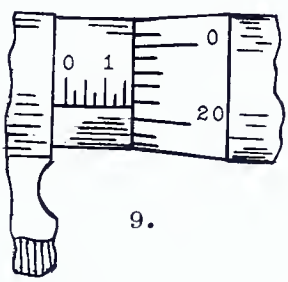

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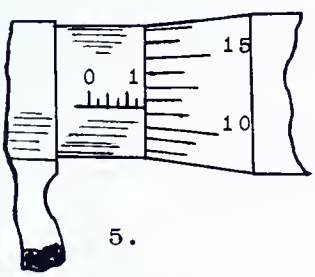

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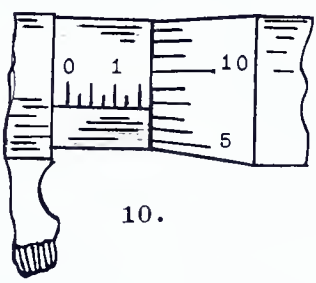


10.

Machinists' Hammer and Center Punch

PURPOSE OF A MACHINISTS' HAMMER

A machinist uses his hammer for tapping bolts home; for making cen ter punch marks; for chipping with a cold chisel; for driving wedges; fo knocking off small pads; for driving pins in and out; for marking gas kets; for cutting holes in gaskets; and for many other such purposes.

The principal reason for listing the above operations is to fix i the mind of the student the fact that a hammer has a definite place o the job. The use of a bolt, a bar of steel, or other makeshift, shoul never be considered. Always use a hammer to do these jobs.

CORRECT USE OF A HAMMER

A careful study of a hammer will show that the handle is evenl balanced in the head. The length of the handle may vary, to suit th individual, but the hand should always grasp the handle close to th outer end and not up at the head end. Holding a hammer close to th head is called "choking the hammer". This is bad practice and cause accidents.

SAFETY

Never strike a hardened surface with a hammer. The face and pee of the hammer are hardened, and two hardened surfaces striking togethe with force may cause the hammer to "spall"; that is, small chips crac off and fly, which may result in eye injury or cuts.

Never use a hammer with a loose handle or a loose "wedge". Th wedge is in the end of the handle to hold it tightly in the head.

Never use the handle as a lever with which to lift or pry.

AN EXAMPLE OF USING A HAMMER

As a hammer and center punch are used frequently, this operation chosen to describe briefly the correct procedure.

1. When using a prick punch, strike a light blow or use a ligh hammer. A heavy blow will break the point of the prick punc and may cause the mark to be "off center". See Fig. 34.
2. When using a center punch, see Fig. 35, one should use a hea ier hammer. One blow with the right weight hammer is all th is necessary, in most cases. Using a light hammer on a hea center punch is not permissible.
3. Hold the center punch square with the work unless it is nece sary to "draw" the punch mark. See Fig. 36.
4. When using a heavy center punch, strike a light blow first be sure the mark is "on center". Then set the mark deeper wi a heavy blow.

Center punch sizes are given by letter in tool catalogs. Howeve many mechanics dress their own center punches to suit their own requir ments.

CAUTION

The top of the center punch will "mushroom" after repeated us Grind the mushroom off before it spalls and causes injury. See Fig. for an illustration of good practice.

Common type of center punch. It has a hardened point. The knurled body gives a better gripping surface for the fingers.

The prick punch. It is smaller and shorter than a center punch. In striking the punch with a hammer, keep the punch straight up and down. When the center mark is not exactly true, lean the punch and "draw" the center over as shown. (Fig. 36.)

Fig. 34

Half size heavy center punch. It is used for very heavy work. *Hexagon Steel.*

Fig. 35

Fig. 37

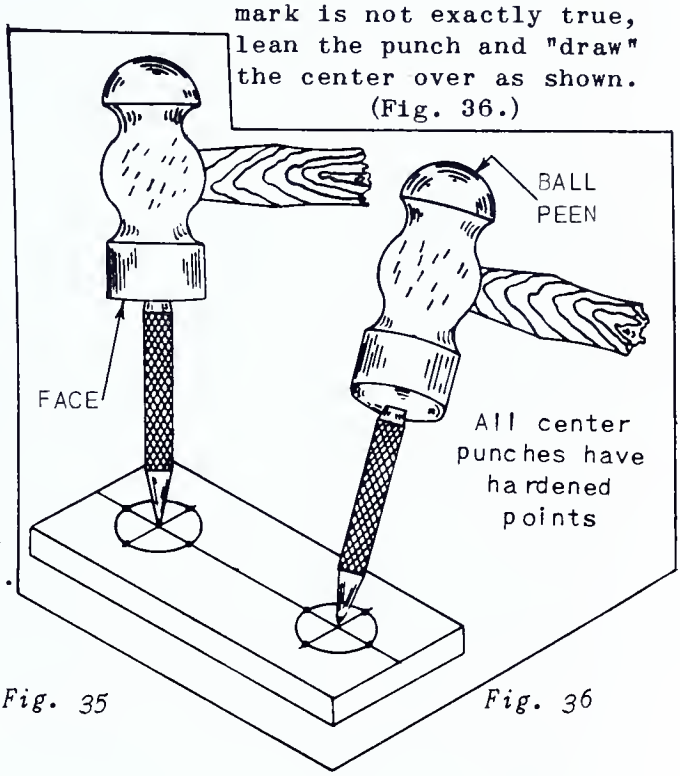


Fig. 36

QUESTIONS

1. Why should a hammer always be used instead of some makeshift?
2. State the correct way to hold a hammer and give reasons.
3. Explain why a hardened surface should never be struck with a machinists' hammer.
4. Point out correct practice in using a hammer with a prick punch and with a heavy center punch.
5. What is likely to happen to a prick punch if it is struck too heavy a blow?
6. Explain the different uses of a prick punch and a center punch.

Cold Chisels: Types and Uses

TYPES OF COLD CHISELS

Many different operations have to be done with cold chisels. There are several types of commonly used chisels. See figures below.

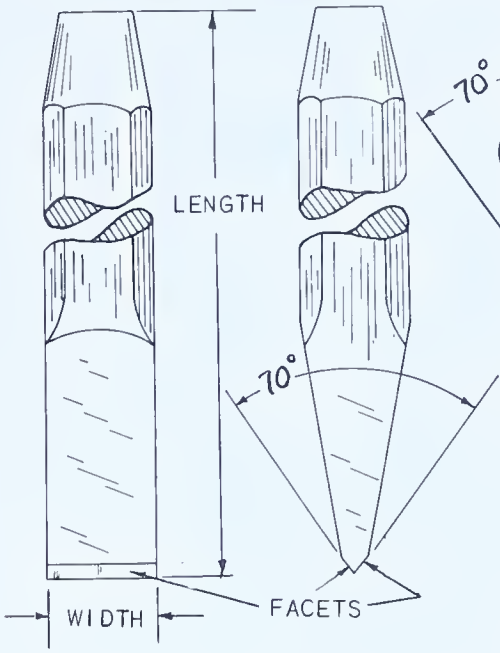


Fig. 38 - Flat Chisel

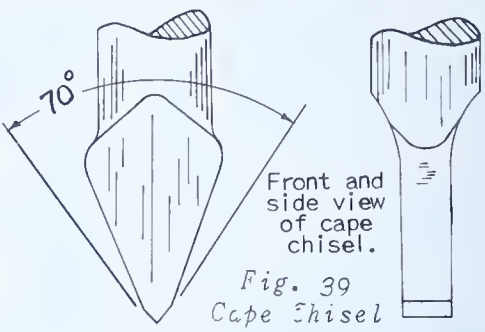


Fig. 39 Cape Chisel

Fig. 40 Diamond Point

Fig. 41 Gouge Chisel

Fig. 42 - Round Nose

The flat chisel, Fig. 38, is used for chi ping rough spots off of flat surfaces, chippi off burrs, smoothing edges, and cutting she metal.

The cape chisel, Fig. 39, is forged narr one way, but it is wide the other way for ext strength. Narrow grooves, slots, and keywa are cut with the cape chisel.

The diamont point chisel, Fig. 40, is ada ted for cutting V-shaped grooves and for chipping out rough spots square corners.

The gouge chisel, Fig. 41, and the rough nose chisel, Fig. 42, a much alike. The gouge is used for roughing out round corners, cutti oil grooves, or drawing a drill to center.

The round nose chisel may be used for trimming round corners off sheet metal or for roughing off convex surfaces and round corners. Co chisels may be any width or length to suit the job.

ISEL TEMPER (Use .75 to .85 Carbon Steel)

All steel is not suitable for making cold chisels. As a chisel must thstand heavy blows repeatedly, it is not practical to harden the whole ol. After the chisel is forged into the desired shape it is annealed, d the cutting edge is tempered and ground to the desired angle. The mper extends about $\frac{3}{4}$ inch from the edge. Flat cold chisels and cape isels are ground on one face only. The stock used is generally octagon shape, but round stock is often used.

FETY

Mushrooming of the top of the chisel will result from ordinary use. ep the mushroom down to a minimum by grinding before it spalls off and rts someone. See Fig. 38 for the correct shape of the head.

Be careful to chip away from anyone working near, and if necessary, ve a warning to avoid injuries. Watch for the corner of a chisel to eak and fly. Use goggles when chipping.

Figure 43 shows how several cuts are aken off the edge of a piece of metal nen chipping. The chip curls ahead f the cutting edge. Taking several cuts is much more quickly nd easily accomplished than rying to do the job with one ut.

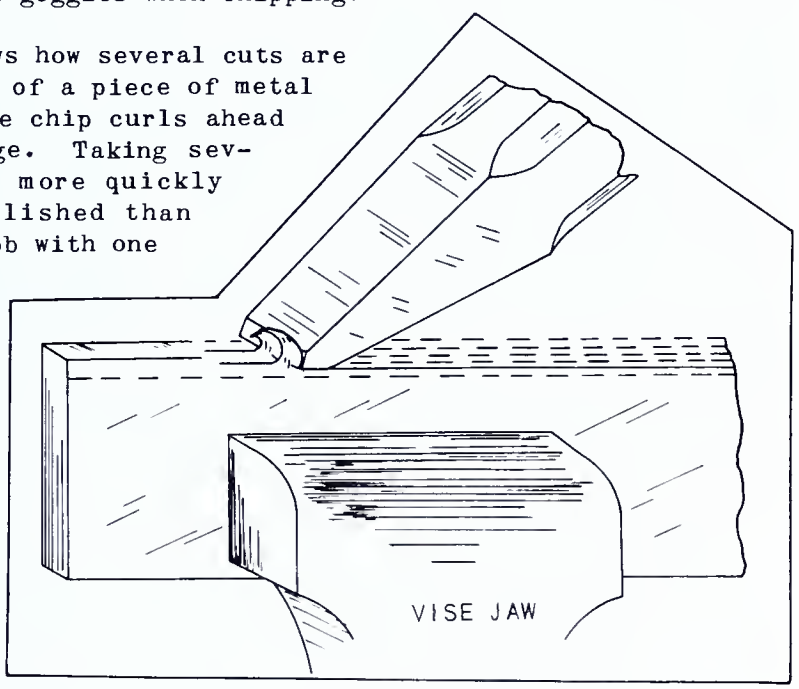


Fig. 43

QUESTIONS

. Explain why a cold chisel is not tempered for the entire length.

. What is the principal difference between a flat cold chisel and a cape chisel?

. What should be done to avoid injury from a mushroomed chisel?

. What chisel should be used when cutting a narrow groove?

. Name one necessary safety precaution when chipping.

Open End Wrenches

PURPOSE OF OPEN END WRENCHES

The name "open end" means that the wrench opening, which fits the nu is cut out at the end of the wrench so the wrench may be slipped on th nut from the side instead of setting the wrench down over the nut as i the case with a box type or socket wrench. See Fig. 44.

The wrench may be applied and the nut turned down very rapidly wit an open end wrench, but care must be taken to use a wrench of the correc size. The size of the opening is usually stamped on the wrench. Ope end wrenches are usually double ended, having different size openings o each end; and the wrenches come in sets.

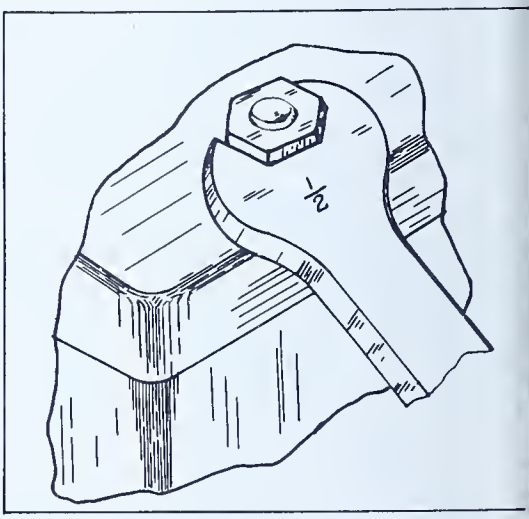


Fig. 44

DETERMINING CORRECT SIZE OPENING

In Merchant Marine Work when figuring the size of the opening for a snug fit on the nut, the rule is: Diameter of bolt x $1\frac{1}{2}$ + 1/8".

For example: Diameter of bolt $\frac{1}{2}$". Size of opening in wrench $\frac{1}{2}$ x $1\frac{1}{2}$ + 1/8" = 7/8".

The U. S. Navy Standard size of wrench opening is diameter of bolt x $1\frac{1}{2}$.

For example: Diameter of bolt is 1/2". Size of opening in wrenc $\frac{1}{2}$ x $1\frac{1}{2}$ = $\frac{3}{4}$".

When too large a wrench is used, the corners of the nut are chew off, making it difficult to get the nut on or off. Wrench opening siz are always measured across the flat of a nut.

CARE OF WRENCHES

Open end wrenches are designed to withstand a pull on the hand about equal to the same force that the bolt will withstand. Hitting t wrench handle with a hammer is poor practice. A jolt with the palm the hand should be sufficient to tighten the nut, ordinarily. In speci cases a short piece of pipe may be slipped over the wrench to give add tional leverage. Be very careful in doing this not to break the wrenc or sheer the bolt.

Never use a wrench as a hammer. A battered wrench always giv trouble.

Questions

1. What is the advantage of an open end wrench?
2. Explain why the correct size opening for the nut should always be used.
3. Where is a nut measured to get the size of the wrench opening?
4. State the rule for finding the size of the wrench opening from the bolt diameter. Commercial? U. S. Navy?
5. Explain how a wrench should be used to draw a nut down snugly.
6. Name some of the troubles encountered with a wrench that has been battered by using the wrench for a hammer.
7. How may the troubles, named in question 6, be avoided?

Drills and Drilling

OF TWIST DRILLS

The outside machinist drills many holes through steel shafting, deck ıtes, bulkheads, etc. Twist drills are kept in the tool crib for the 'pose of filling the mechanics' needs. As these tools are made of high 'bon or high speed steel, they may be easily broken. Either the cutting ;es may be chipped or the drill may be snapped off short if the work- does not take care to hold the drill steady while drilling.

LL FEEDS

The action of forcing the drill into the work is called the "feed". much force applied to the feed, especially with the smaller size lls, will very likely break the drill.

When drilling at an angle, feed very slowly until the drill is cut- ıg "to size". This means until the drill has entered far enough for of the drill point to be below the surface of the work and then the ll cannot slip, but it can be leaned sidewise and cramped, causing it break. Be careful to avoid this.

'ES OF DRILLS

Up to 3/16" in diameter the drill shank is straight. See Fig. 45. ew drills above 3/16" may be straight, but they are usually tapered. ıered shank drills hold better in the drill chuck without slipping ın do straight shank drills. See Fig. 46.

Taper shanks are not all the same size. Larger drills have larger ınks, and of course provision must be made for the drills to fit the ll chuck. All tapered shank drills are usable in one drill chuck by ıloying taper sleeves in the chuck. The sleeve has a tapered hole ch fits the drill shank taper and the outside of the sleeve fits the e in the drill chuck. Both sleeve and drill must be securely insert- to prevent slipping. See Fig. 49.

AT SIDE TAPERS

Most shipyard air drilling machines have a flat side in the chuck ıer. There is a corresponding flat on the taper shank of the drill.

There is very little danger that this type of drill will slip in chuck. See Figs. 50, 51, and 52.

CAUTION

Wipe the hole in the chuck and the shank of the drill with a rag o some clean waste before inserting the drill in the chuck. Never allo dirt or grit to remain on these surfaces. The drill will be thrown ou of line and the tapers scored.

When removing the drill from the chuck, use a drift made for th purpose. Never strike the drill to loosen it from the chuck or sleeve.

A drift is a piece of steel tapered like a wedge. The drift thic ness fits the width of the slot in the chuck spindle or tapered sleeve The thin edge of the wedge is inserted in the slot between the end of th drill shank and the upper end of the slot. As the drift (wedge) i driven inward, it forces the drill downward. A light blow is sufficien in most cases.

GRINDING DRILLS

Always examine drills when getting them out of the tool crib. dull drill never cuts well and is likely to "burn" (lose its tempe if used. If the drill is dull, have it ground or exchange it for anot er at once. If by some accident or mishandling the drill is broken chipped while in use, have it replaced or ground immediately. Do n risk spoiling a job by trying to use a faulty tool. Be sure the to crib attendant furnishes the size drills requested when applying at t tool crib window for drills.

LUBRICATION

When drilling cast iron no lubricant is necessary. Use a lig lubricant for steel. The lubricant acts as a coolant and prevents t drill from burning. Sometimes a hard spot is encountered in the meta Continuous drilling on such a hard spot may ruin the drill point. T addition of lubricant will not help the situation in most cases. U a high speed drill (this does not mean run the drill at high speed) chip the hard particle out with a gouge or diamond point chisel. If is found that the metal is hard, stop at once. Hardened metal must annealed before it can be drilled. An application of heat with acetylene torch may help, but the metal should be covered and allowed cool slowly before proceeding. In case heat is not available or a pa can not be heated owing to the grade of steel or other parts near being affected by the heat, use a little turpentine and grind the dri often.

When drilling brass use a very light oil, or drilling compound. T cutting lips of the drill must be ground with a neutral rake to preve "hogging in". Hogging is very likely to occur when following a pil hole. Be sure the cutting lips of the drill are ground to the sa length.

STARTING A LARGE DRILL

Drills of $1\frac{1}{2}$" diameter and larger do not start very easily in a c ter punch mark. The best thing to do in this case is to drill a "pi hole" first. The size of the pilot hole used is from 3/16" to 1/4".

int of the drill should clean just a little stock out of the pilot le as the drilling progresses. See Fig. 48.

There is one thing to watch when drilling the large hole through the lot hole. The large drill will "hog in" (catch and break) if the feed not eased up at the finish of the drilling. Go carefully on the first w holes and experience will show just how much to ease up the pressure wards the end of the drilling.

LOCATING A HOLE

All the important holes should be "laid out" before commencing to ill. This is done by prick punching the exact center at the intersecon of two lines. The dividers are then used (See Page 35) to lay out e size of the hole. Chalk the surface before marking the circle. Prick nch the circle in at least four places. (Large holes need more prick nch marks.) Prick punch marks should be placed about every 1/2" on the rcle circumference. Sometimes a "witness" circle is scribed around the le circle about 1/16" away from the first circle. If the drill begins "run" it will be noticed at once.

"DRAWING" A DRILL

When drilling a hole without using a pilot hole, the drill may "run ". See Fig. 47. The operator should raise the drill from the work inspect the cutting location before the drill has gone in far enough cut to size. If the hole shows signs of running off, chip a groove h a gouge chisel on the wide side of the layout. See Fig. 41. This oove will cause the drill to "bite in" each time the cutting edge hits groove. If the drill is still off after a few more turns, chip the oove again until the drill is cutting central with the layout. The structor will demonstrate the correct procedure.

When drilling a hole following a pilot hole the drill cannot be awn over. This means that extra care must be used when drilling the ot hole.

DRILL SIZES

Ordinarily, drill sizes are stamped on the shank in fractions of an ch. Nearly all drills used by the outside machinist are stamped in act 64ths. For example: 1/4"; 21/32"; 41/64"; 1-17/64"; 1-1/8"; 3/16", and many others.

There may be a few cases where it is necessary to use a drill which not exact 64ths in size. Then "letter" drill sizes are used. Such ill sizes are:

D - .246 diameter, a driving fit for 1/4" diameter pin.
N - .302 " " " " " 5/16" " "
U - .368 " " " " " 3/8" " "

There is a drill size for every letter in the alphabet. Some Letsizes are "even" fractional dimensions, such as:

H drill exactly 17/64" diameter .266
M " " 19/64" " .295
T " " 23/64" " .358

There are many others. (See page 263, Starrett Catalog, No. 26.) special cases where these drills are to be used, see the instructor.

CUTTING SPEEDS OF DRILLS

Circumstances control the cutting speed of drills in most cases. Small drills run much faster than the larger drills. This is a matter for good judgment. A good rule to follow is:

35' per minute for cast iron
60' per minute for steel
60' per minute for brass

If it is found that the drill will cut well, hold its edge, and d a good job at a higher rate of speed; step up the speed.

It is better to run a drill slowly and step up the speed rather tha to begin at high speed and possibly burn the drill. Check with the in structor or leader.

DRILLING A FLAT BOTTOM HOLE

Drill the hole to the correct depth, measuring from the center o the drilled hole to the surface of the work. Be careful to measure t the *center* of the hole. Flat bottom holes are usually drilled in th shop. The outside machinist drills this kind of hole only when instruc ted to do so. Ordinarily a hole is drilled a little deeper than usual to allow a plug tap to reach the bottom and cut enough thread.

Replace the regular drill with a stub drill: One that has bee ground off square on the end. Finish the bottom of the hole flat wi the stub drill. Feed slowly and carefully. Sometimes a reamer, cut lil an end mill, is used for this job. Check with the leader when there a job of this kind to do.

Flat bottom holes are tapped when a cap screw or bolt is used. this case no nut is used on the bolt. The threads are in the hole a the cap screw is turned in with a wrench. Flat bottom holes are al used for studs (bolts with a thread on both ends and a nut on one end Removing Studs or Broken Bolts, page 67, Fig. 81.

ENLARGING HOLES ALREADY DRILLED

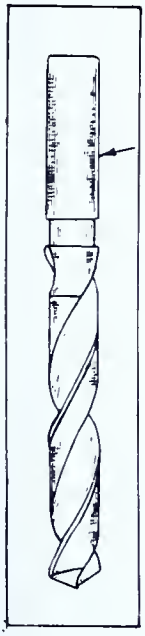
Consider a 1" hole drilled through a hub or a thick plate. Perha it is necessary to enlarge the hole 1/4". The drill will have a tenden to "hog in" when starting the larger drill in the hole. Run the dri slowly and feed lightly. The drill will hog into steel or brass more th it will in cast iron. It may be necessary to grind the "rake" off the cutting lips of the drill. Check with the leader in such cases.

DRILLING COMPARED WITH BORING

Holes larger than two inches are spoken of in the shop as bei "bored". The reason is that the job is done in a boring mill or lath When such a job has to be done in the yard, it is sometimes necessary use a drilling post, or "old man", as it is called. This is a devi which may be clamped to the deck or bulkhead, and constant pressu (feed) is applied by means of a screw.

A "drill stick" is also used; it will be explained in the manu later.

For very large holes the boring is done with the use of a "bori bar" and a reduction-driven drill or reamer. This operation will explained later in another section of the manual.



Tighten a straight shank drill securely in the chuck to prevent scoring the body of the drill shank.

Fig. 45

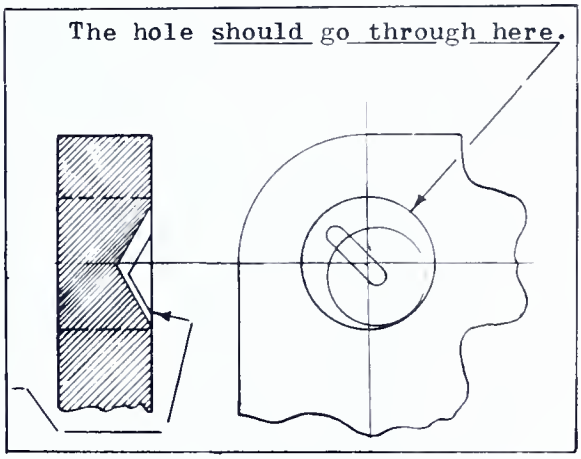
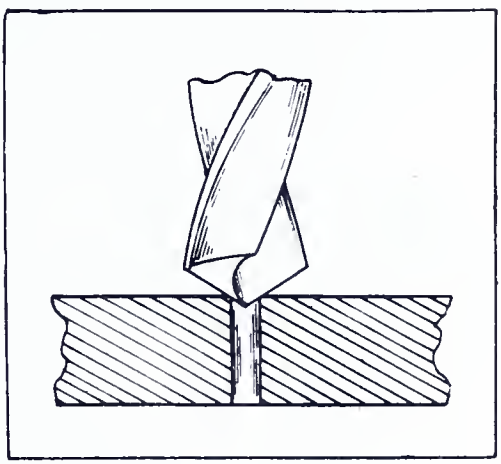


Fig. 47

"Draw" the drill back "to center" by chipping groove as shown. Use a gouge chisel to chip the groove.

Flat side on taper shank drill prevents turning in the chuck. Taper shank holds drill in chuck without tightening.

Fig. 46



Following a pilot hole, the drill has no chance to run off. Be sure the pilot hole is correctly centered before starting the large drill.

Fig. 48

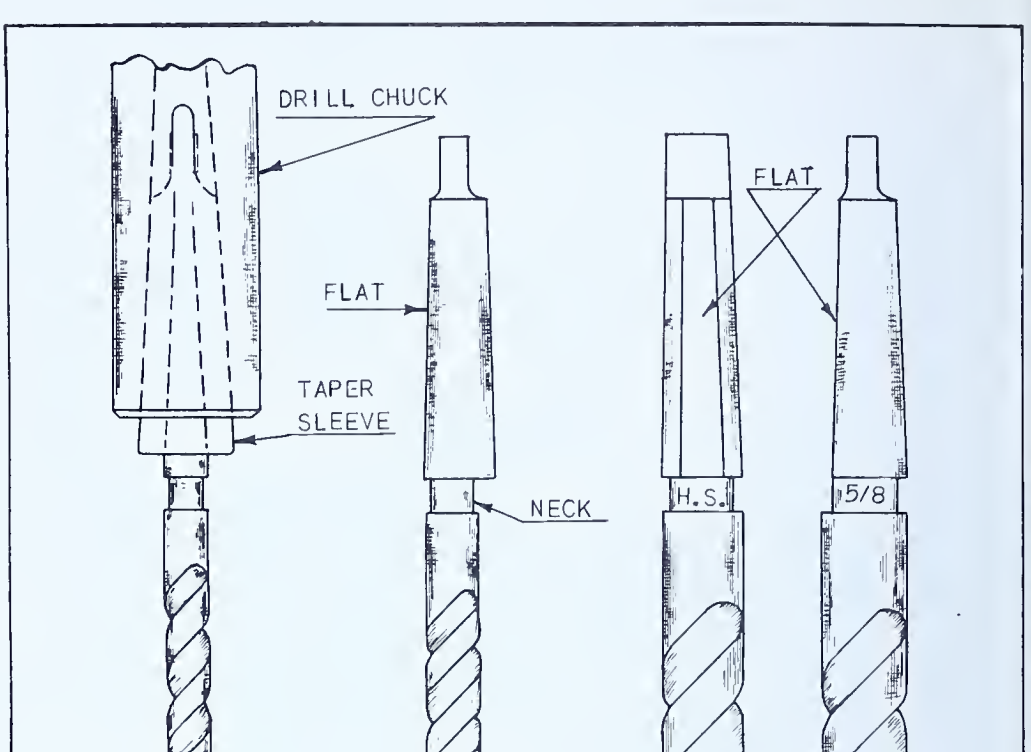
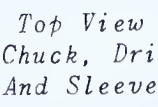


Fig. 49 *Fig. 50* *Fig. 51* *Fig. 52*

Top View Of Chuck, Drill, And Sleeve



The taper sleeve is used to make up for the difference between the size of the hole in the chuck and the taper shank of a small drill.

Showing a taper shank drill with the shank larger than the drill.

Care must be taken not to apply too much pressure and snap the drill at the neck.

Two views of a tap shank twist drill with "flat" to prevent turning in the chuck.

Top views of taper shank drill

QUESTIONS

1. What is understood by a "drill feed"?
2. Explain the difference between a straight shank and a taper shank.
3. Why are the taper shank drills flatted off on one side?
4. What is the correct method of removing a drill from the chuck or sleeve?
5. Explain what is meant by "burning" a drill. What causes it?
6. When is a lubricant on a drill necessary?
7. Explain the action of a lubricant.
8. What is meant by a "pilot hole"?
9. Explain the necessity for a pilot hole.
10. State precautions necessary when following a pilot hole.
11. What is understood by the statement: The drill may "run off"?
12. How is a drill "drawn" back to center?
13. Name two ways to check the size of a drill.
14. What are letter size drills?
15. Is the cutting speed for brass different from that for cast iron? How much different?
16. State two ways to drill a flat bottom hole.
17. Explain the difference between "drilling" and "boring".
18. What is the correct procedure when a drill cutting lip breaks off? State the probable cause.
19. What is a "drift" when mentioned in connection with drilling?

Reamers and Reaming

JRPOSE OF REAMERS

A drilled hole is never so true to size as a reamed hole. Holes 're drilled before they are reamed. The reason for reaming a hole is to ıke a snug, uniform fit for a straight pin, a shaft, a taper pin, a .tted bolt, and other similar fits.

'PES OF REAMERS

Some reamers are used in an air drilling machine. Reamers are gen-'ally classified as:

1. Fluted reamer, taper shank
2. Rose reamer, straight or taper shank
3. Shell reamer, used with a shell-reamer arbor
4. Hand reamers:
    1. With spiral teeth
    2. With regular (straight) teeth
5. Expansion reamer, hand
6. Taper reamer, hand
7. Taper reamers, machine

USES OF REAMERS

SHELL REAMERS are usually large in diameter, running as much as 6 inches. These reamers are hollow. The inside hole is tapered to fit the taper of a specially made arbor, the opposite end of which fits the taper in a drilling machine chuck. Two square driving blocks fit corresponding notches in the shell reamer. Many different sizes of reamers will fit the same arbor. See Fig. 53.

Shell reamers are made either fluted or rose type, and the cutting action is exactly the same as for the smaller sizes.

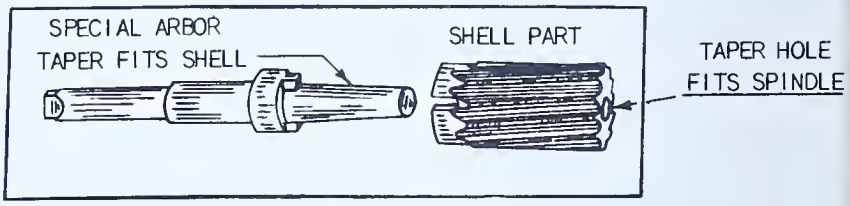


Fig. 53

THE FLUTED REAMER is used where great accuracy is not required. The teeth are spaced fairly close together and the reamer cuts fast enough for an ordinary job. The cutting is done along the sides of the teeth which are separated by the flutes. See Fig. 54.

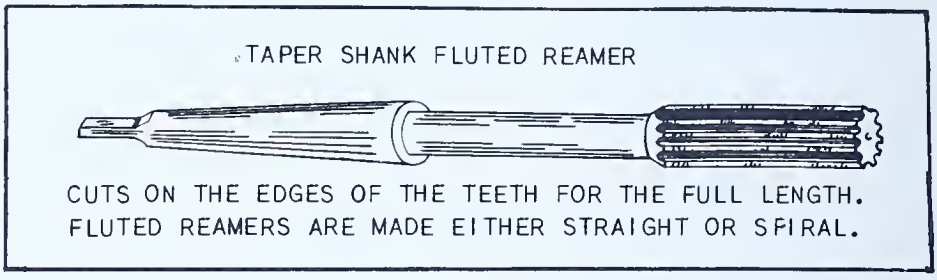

TAPER SHANK FLUTED REAMER
CUTS ON THE EDGES OF THE TEETH FOR THE FULL LENGTH.
FLUTED REAMERS ARE MADE EITHER STRAIGHT OR SPIRAL.

Fig. 54

THE ROSE REAMER cuts only on the end. The teeth are shaped to cut ahead of the body of the reamer. The flutes allow the chips to get out of the hole and also provide a way for the lubricant to get into the cutting end. The rose reamer is not expected to cut a very smooth hole, as it is made a few thousandths under-size, so that the hole may be finished out accurately with a hand reamer. Rose reamers are sometimes used to make a flat bottom hole for a stud. See Fig. 55.

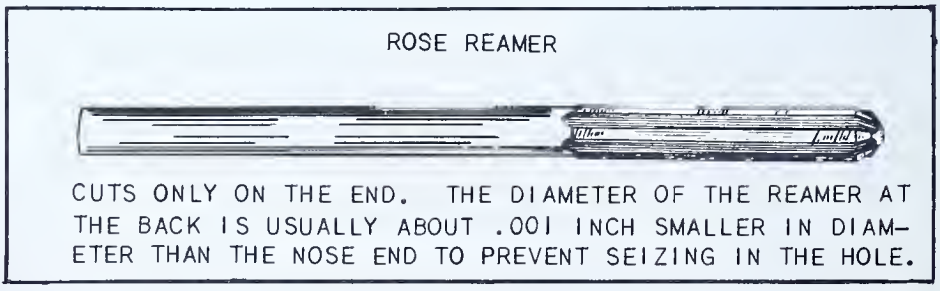

ROSE REAMER
CUTS ONLY ON THE END. THE DIAMETER OF THE REAMER AT THE BACK IS USUALLY ABOUT .001 INCH SMALLER IN DIAMETER THAN THE NOSE END TO PREVENT SEIZING IN THE HOLE.

Fig. 55

HAND REAMERS are made to exact sizes and may have either spiral teeth straight teeth. The spiral-tooth reamer cuts much more smoothly than he straight tooth. For a very smooth, accurate job the spiral reamer s the better one to use. See Fig. 56.

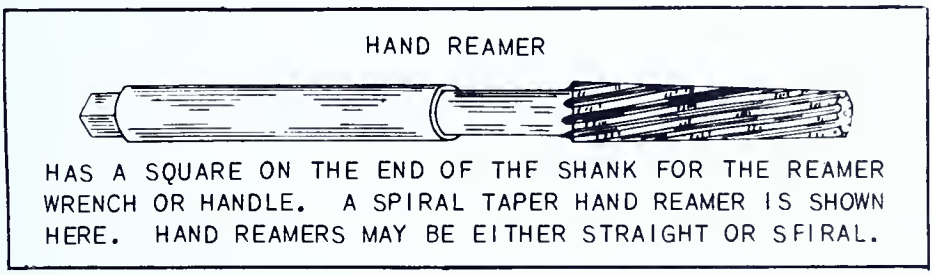

HAND REAMER
HAS A SQUARE ON THE END OF THE SHANK FOR THE REAMER WRENCH OR HANDLE. A SPIRAL TAPER HAND REAMER IS SHOWN HERE. HAND REAMERS MAY BE EITHER STRAIGHT OR SPIRAL.

Fig. 56

THE HAND EXPANSION REAMER is made especially for close work. The eamer has slits along the body and a tapered hole through the center. taper plug is closely fitted to the taper hole in the reamer, and by eans of a screw the reamer teeth can be swelled out to a barrel-like urve, causing the reamer to cut a few thousandths over size. The reason or the expansion feature of the reamer is to provide for its longer sefulness. Any wear is taken up by the taper adjustment. See Fig. 57.

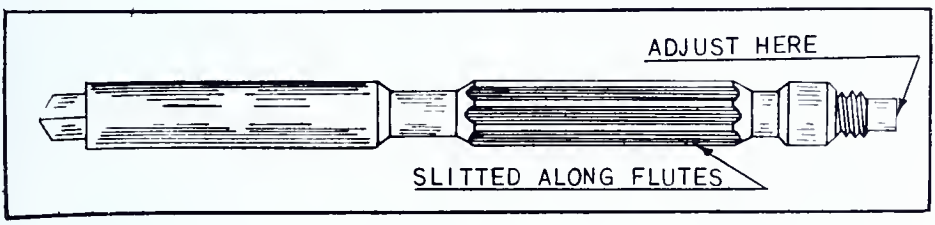


Fig. 57

TAPER REAMERS are made for hand and machine use. When hanging brass perating-rod ends on a deck-stand, the upper and lower collars are se- ured in the correct location on the rod with taper pins. A taper eamer is used to ream the hole to the correct size. See Fig. 58.

When two holes do not line up exactly in steel plates that are being iveted or temporarily bolted together, a machine taper reamer may be sed to cut the opposite edges of the two holes enough to slip a bolt or ivet through.

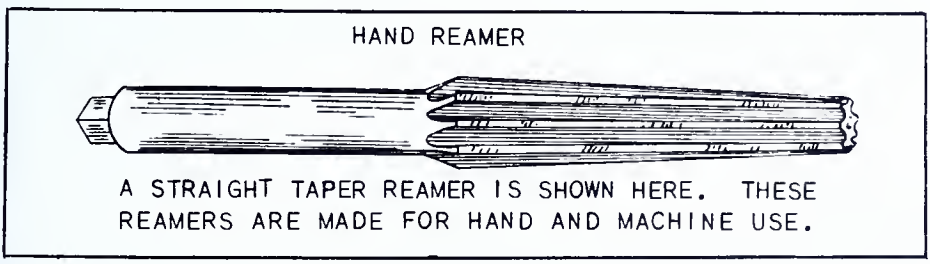


Fig. 58

CARE OF REAMERS

Throwing reamers around carelessly, using a reamer for a hammer leaving a reamer in the drill chuck after using, or anything else tha will allow the reamer teeth to become damaged or broken, is not goo practice.

Reamers are high-grade tools, very expensive, and sometimes hard t replace. A reamer may be sharpened by grinding in the tool room, bu the nicks and broken places cannot be repaired.

Do not allow reamers to get rusty, and do not return them to th tool room dirty.

Be careful to use the correct size holder on a hand-reamer squar If a wrench is used, be sure it fits the square tightly.

Accidents happen with tools. Report broken or damaged tools imm diately. This will give the leader a chance to do something about r placements. Do not let the job be held up for lack of planning.

QUESTIONS

1. Name two reasons for reaming a hole.
2. What is the principal difference between hand and machine reamers?
3. Explain the advantage of a spiral reamer as compared with a regular reamer.
4. Why are expansion reamers constructed so that the diameters may be adjusted?
5. Where is the cutting edge on a rose reamer?
6. What is meant by a shell-reamer arbor?
7. Name the type of reamer used to ream a hole for a taper pin.
8. State what type of reamer to use and what to do when two holes are out of line so that a rivet or bolt will not go through.
9. How may the teeth of reamers be ruined?
10. Name a few items of what to do before returning a reamer to the tool crib.
11. What should be done in the case of a broken or damaged reamer?
12. Where is the square on a hand reamer and for what is it used?

Reaming Through Holes

REAMING BY HAND

Reaming a hole is done to bring the hole to an exact size. For ample: When fitting a straight pin to a hole where a snug fit is n essary, first drill the hole 1/64" to 1/32" smaller than the pin, and t

e a hand reamer which is the size of the pin. See Fig. 59, "a". An pansion reamer (Page 47) is often used to ream a straight hole to fit pin.

AMING TAPER HOLES

It is always necessary to use a taper reamer to fit a tapered pin. ig. 60). The hole is first drilled about the size of the small end of e tapered pin and a taper reamer is then used to taper the hole to fit e pin. Use the same number taper reamer as the pin number. See Fig. , "b". Care must be used when reaming with a taper reamer or the hole ll be reamed too large. A taper reamer is not like a straight reamer one respect: One turn with a taper reamer can mean the difference be- teen a good fit and a spoiled piece of work. For this reason it is fer to use a hand reamer on such jobs.

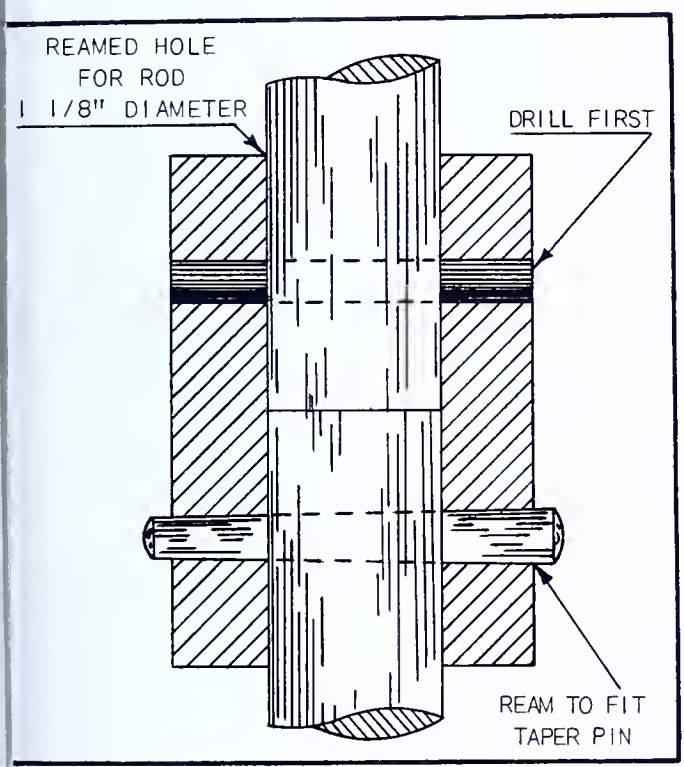


Fig. 59

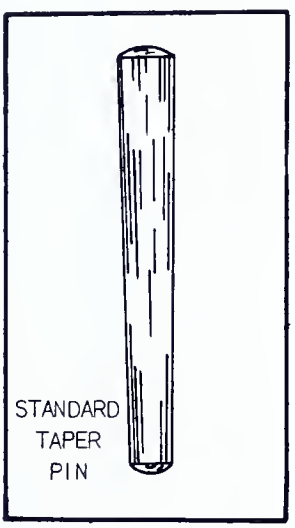


Fig. 60

Never try to bring a hole to "position" with a hand reamer. The amer follows the drilled hole. Trying to change the direction of the le by leaning the reamer or applying more pressure on one side will be eless and may possibly break the reamer.

AMING BY AIR MACHINE

Great care must be used when reaming very small holes by machine. e air machine is heavy, and the operator cannot easily get the "feel" a small reamer to an extent which will prevent breakage. This is not likely to happen with larger reamers. The job may be done much more ickly by using the air machine. Use a small machine for a small job.

KEEPING THE REAMER IN LINE

When reaming with the air machine, keep the reamer "in line". Wob bling around on the start will affect the size of the hole. After th reamer has entered the hole, it must be kept in line to prevent breaking

When the depth of the reamed hole is very great, more care must b taken. Reaming holes for dowel pins, or reaming holes through unit base and foundations for fitted bolts calls for careful handling of the ai machine and reamer.

GENERAL PROCEDURE

The general procedure for reaming holes through a base and founda tion is as follows:

NOTE: A generator base frequently has 7/8" drilled holes in th corners when it is delivered by the manufacturer. The othe holes in the base are about 1" drilled and not reamed, and a black iron bolt of the proper size is used to bolt the unit at these places.

1. With the proper size drill in the "corner air drilling machine" drill the foundation on the corners, using the drilled hole in the base of the unit as a guide. See Fig. 61.

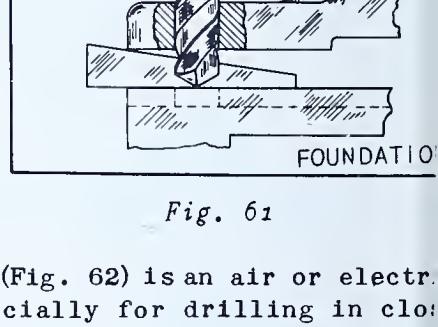


Fig. 61

NOTE: A corner air drilling machine (Fig. 62) is an air or electr motor driven device made especially for drilling in clo corners.

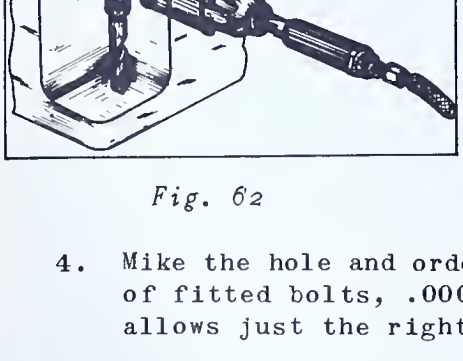


Fig. 62

2. If the corner hole is 7/8" diamete run a 15/16" reamer through, aft drilling the 7/8" hole.

3. Now run a 1" reamer through, whi will remove 1/32" stock on a mid

4. Mike the hole and order from the machine shop the right numb of fitted bolts, .00025 per inch larger than the hole. Th allows just the right amount for a drive fit.

NOTE: On some heavy installations the corner holes are rea to 1.500 diameter, and the bolts are made 1.503" for snug fit. In those cases a bushing is placed in t

drilled hole in the base and a 3/8" pilot hole is drilled in the foundation. The bushing acts as a guide in centering the 3/8" pilot hole. See Fig. 63.

The 3/8" diameter hole is now the center for a 1-7/16" diameter drill, which is run through next, the drill passing through and enlarging the hole in the unit base and then following the 3/8" hole through the foundation. See Fig. 64.

A 1.500 reamer is now run through the holes, and the job is ready for the fitted bolt. See Fig. 65.

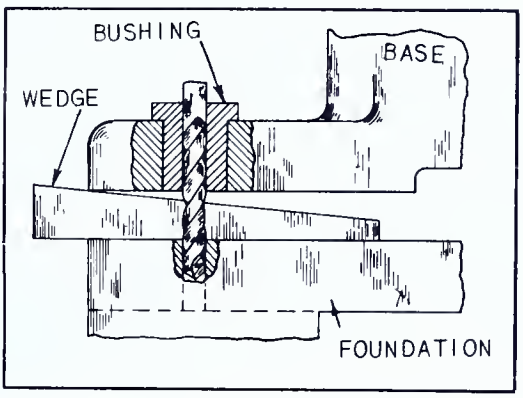


Fig. 63

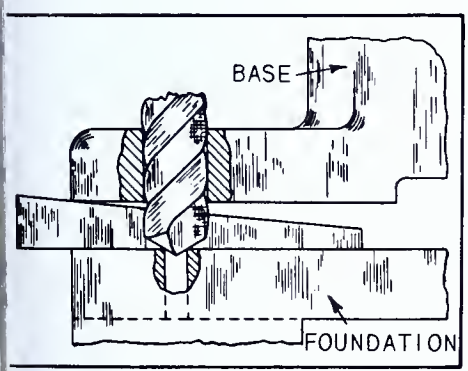


Fig. 64

rilling a foundation, using he hole in the base as a uide and following the pilot ole in the foundation, pre- iously drilled through when he bushing in Fig. 63 was used as a guide.

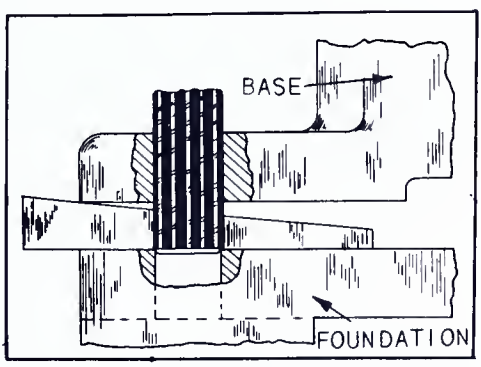


Fig. 65

Reaming both holes through the base and the foundation with a straight reamer. The reamer follows the drilled hole. Keep the reamer vertical.

QUESTIONS

1. Explain what is meant by reaming "through holes".

2. State the procedure for drilling and reaming where a coupling must be prepared to couple two rods or shafts.

3. How is the drill size determined when drilling a hole that is to be reamed for a taper pin?

4. Compare the uses of a large drilling machine and a small drilling machine.

5. State which of the following size reamers should be used in a large drilling machine: 3/8" reamer, 1" reamer, 1/2" reamer, 1-1/2" reamer, 5/8" reamer, #2 taper reamer.

6. How much stock is allowed in the diameter of a hole for reaming?

7. Name the correct size drill to use when a hole must be reamed 15/16" diameter.

8. How is the size of a fitted bolt given to the shop when ordering a number of fitted bolts?

9. State the size to give the shop for fitted bolts which are to be used in 1-1/4" reamed holes.

10. If the holes in the pedestal are 1-1/2" diameter, what is the procedure for drilling the holes in the foundation?

11. What is the purpose of a pilot hole?

12. Explain the reason for using a spiral fluted reamer instead of a straight fluted reamer.

Using a Portable Air Drill

Fig. 66 - Drilling With a Corner Machine

IR MOTOR

An air motor "a", Fig. 67, may be used for drilling, boring, reaming, grinding, and other operations that require the use of a portable otating tool. One section of the handle is turned to start or stop he motor. The lead hose "b", (also called a whip), is a six-foot length f hose with one connection threaded to screw into the motor handle. n the other end is a universal hose coupling. In some instances the ead hose is wrapped with wire in order to reduce wear.

ESCRIPTION OF AN AIR HOSE

Air hose is constructed of braided cord and rubber. The rubber hould be tough and oil-resistant. Universal air hose couplings are ombination male and female, and are attached at each hose end. The ir connection manifold is joined to a main air line and has two or ore air hose connections. Each connection has a quarter turn cut-off.

IGGING AN AIR MOTOR

To rig an air motor, screw the threaded end of the lead hose into he motor handle, couple the other end of the lead hose to one end of he air hose, and couple the other end of the air hose to manifold connection.

DRILL FEED

The feed wheel "f" is made on a long shaft "g", Fig. 67, which is threaded into the body of the air motor. The upper end of this shaft is placed under the arm of an "old man"; then when the wheel is turned, the shaft screws out of the body of the motor, forcing the motor down and thereby putting pressure on the drill.

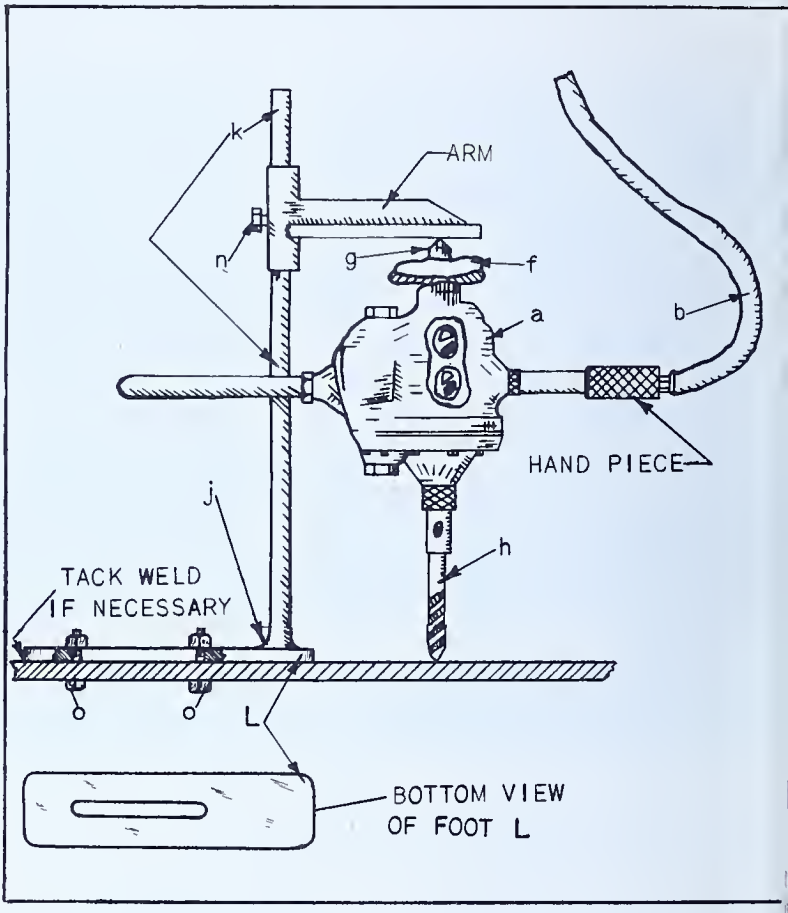


Fig. 67

The feed wheel may be turned the other way far enough to cause the lower end of the shaft to force the taper drill "h" from its socket. Care should be taken that the feed wheel raises shaft "g", Fig. 67, high enough to allow drill "h" to seat properly before starting to drill. There should be a small space between the upper end of the drill and the lower end of the shaft "g" Fig. 67.

USING A DRILLING POST

A drilling post, commonly called "old man" is a tool used to assist the operator of a drill in forcing the drill through the material. "k". Fig. 67.

The foot "1" is slotted lengthwise. A bolt is placed in this slot to clamp the foot to the material. The post "j" is screwed or welded into the foot. The arm may be raised and lowered on the post and clamped at any height or angle around the post by clamp bolt "n". The under side of the arm has many small counter sunk places to fit the tapered end of a drill feed post.

Fig. 68 Applying the "feed" with a Drilling Stick

NG A DRILLING STICK

Instead of using an "old man", a "stick" is used on many jobs to ly the feed to an air drill. Fig. 68 shows a stick in use.

The "stick" is made in the carpenter shop and sometimes will serve several jobs. It should be laid away for future jobs until after eated use it becomes unfit for service. Fig. 69 shows how the bolt bent to act as one end of a clamp and placed through a convenient e. See Fig. 69 at "t". The rod is put through the hole in the plate e Fig. 70) as at "y" and raised to a vertical position as at "z". The is adjusted to the correct height to obtain the maximum pressure.

TO SET UP A PORTABLE AIR DRILL

CEDURE (Applicable to most jobs)

1. Place the foot "L" across the hole on top of the plate. See Fig. 67.
2. Clamp the foot to the plate, using a "C" clamp or other clamping device. If there is a convenient hole in the plate, use it.

NOTE: Place bolt "o" through the slot in the foot and the hole in plate and tighten it securely. This clamps the "old man" to the plate. When a "C" clamp will not reach and there are no holes which may be used for bolting down, tack-weld a bolt to the plate for clamping down the foot of the "old man". See that the weld is removed after the job is finished.

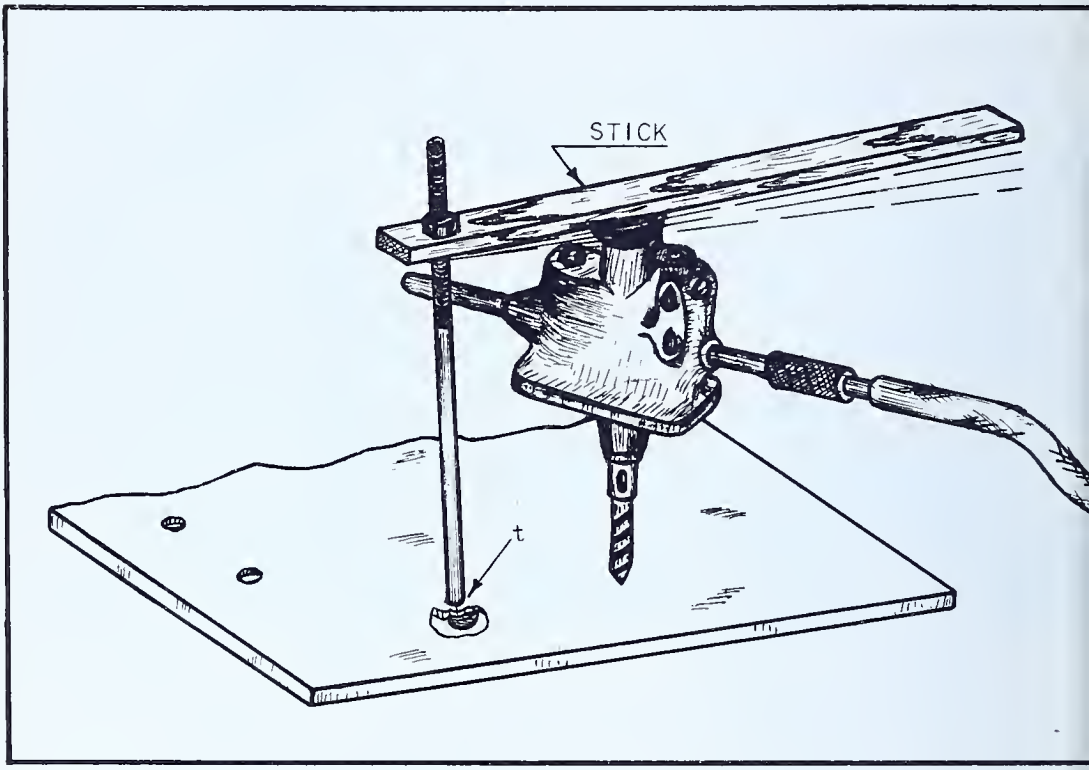


Fig. 69

3. Place the drill in position to drill the hole.

4. Swing the arm around over the top of the drill and fit the pered end of the feed post into a countersunk hole in the a The arm has many of these and the one that lines up with feed post is the correct one. If a hole in the arm does line up with the tapered end of the feed post, move the f "1" to bring a convenient hole into a vertical line with point of the drill. See Fig. 66.

5. Clamp the arm in position with clamp bolt "n".

6. Turn the feed wheel and press the drill firmly into place.

7. Oil the drill point and start drilling.

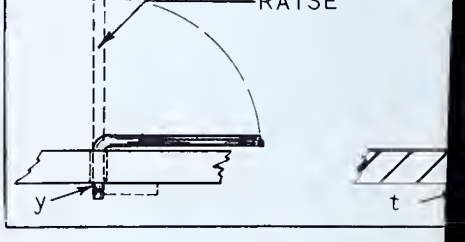


Fig. 70

8. Turn the feed wheel slowly while the drill turns, until hole is drilled. Turn the feed wheel and press drill firml place. Check to see that drill lines square with work.

QUESTIONS

1. Explain the reason for using an air drill.
2. State the reason for using an "old man" with an air drill.
3. Name the several parts of an air drill.
4. For what purpose is the foot of the "old man" used?
5. Explain how the feed is applied to the drill when using an air drilling machine.
6. Is the foot of the "old man" tack welded to the plate or deck when convenient bolt holes may be used?
7. What is understood by the term "drilling stick"?
8. Explain the difference between a "corner drilling machine" and an ordinary air drill.
9. Where is a corner drilling machine used? Why?
10. How is the drill secured in the air drill chuck?
11. Why is there a flat surface on the taper shank of a drill?
12. For what purpose is a sleeve used in an air drill chuck?
13. What precautions should be observed when using a small drill in an air drill?
14. Describe the correct procedure and state what equipment is used when using a drilling stick and an air drill.
15. State the reasons for applying lubricating oil to the work when drilling a hole.

lapted from "Shipyard Outside Machinist," by State Department
Education, Alabama.

Threading Bolts and Nuts

STANDARD SCREW THREADS

In order that all bolts and nuts may fit other bolts and nut wherever they may be made, a certain number of threads is always c on the same diameter bolt or inside the nut. A table of the more co monly used threads for bolts and nuts is given below:

American Standard Screw Threads, N. C.

BOLT SIZE	THREADS PER INCH	SIZE DRILL FOR HOLE	SIZE ACROSS FLAT OF NUT
1/4	20	13/64	1/2
5/16	18	1/4	19/32
3/8	16	5/16	11/16
7/16	14	23/64	25/32
1/2	13	27/64	7/8
9/16	12	15/32	31/32
5/8	11	17/32	1- 1/16
3/4	10	41/64	1- 1/4
7/8	9	3/4	1- 7/16
1	8	55/64	1- 5/8
1-1/8	7	31/32	1-13/16
1-1/4	7	1- 3/32	2
1-3/8	6	1- 7/32	2- 3/16
1-1/2	6	1-11/32	2- 3/8
1-5/8	5-1/2	1-27/64	2- 9/16
1-3/4	5	1-17/32	2- 3/4
1-7/8	5	1-21/32	2-15/16
2	4-1/2	1-49/64	3- 1/8
2-1/4	4-1/2	2- 1/64	3- 1/2
2-1/2	4	2-15/64	3- 7/8
2-3/4	4	2-31/64	4- 1/4
3	3-1/2	2-11/16	4- 5/8
3-1/4	3-1/2	2-15/16	5
3-1/2	3-1/4	3-11/64	5- 3/8
3-3/4	3	3- 3/8	5- 3/4
4	3	3- 5/8	6- 1/8
4-1/4	2-7/8	3-27/32	6- 1/2
4-1/2	2-3/4	4- 3/32	6- 7/8
4-3/4	2-5/8	4- 5/16	7- 1/4
5	2-1/2	4- 9/16	7- 5/8
5-1/4	2-1/2	4-13/16	8
5-1/2	2-3/8	5- 1/32	8- 3/8
5-3/4	2-3/8	5- 9/32	8- 3/4
6	2-1/4	5- 1/2	9- 1/8

NOTE: There are two series of American Standard Screw Threa They are Nation Fine (N. F.) and National Coarse (N. C.). The Natio Coarse threads are generally used in Commercial shipyard work. B series are derived from the United States Standard. (U. S. S.). U. S. Navy uses Navy Standards.

IZE OF WRENCH OPENING FOR NUTS

For Commercial shipyard work the size of the opening in a wrench is ased on the diameter of the bolt multiplied by 1-1/2 plus 1/8 inch. For xample: The size of the wrench opening for a 1/2 inch nut is 1/2 x -1/2 3/4. Adding 1/8 inch gives 7/8 inch as the size of the nut across he flats. The U. S. Navy standard opening in a wrench for a 1/2" nut is he diameter of the bolt multiplied by 1/2. For example: 1/2 x 1-1/2 /4. Note that nothing is added after the multiplication 3/4" is the ize of the nut across the flats.

THE TAPER TAP is generally used to tap a hole in a nut or in a piece f work where the hole goes all the way through the metal. See Fig. 71. his tap may be used in a very deep "blind" hole. A "through" hole is rilled completely through, and a "blind" hole is drilled only part way hrough. A taper tap will "bottom" in a blind hole before a full thread s cut. See Fig. 72.

Use a PLUG TAP when tapping a blind hole. Run the tap in as far as ossible and back it out. Now use the bottoming tap, which will cut a hread all the way to the bottom of the hole. See Fig. 73.

AUTION

Never force a tap. Remember they are hardened and will snap off

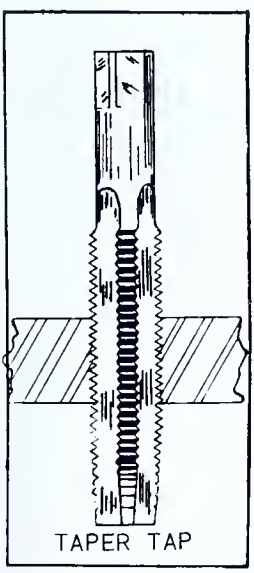


Fig. 71

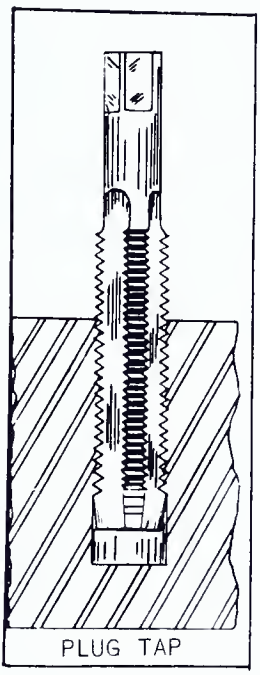


Fig. 72

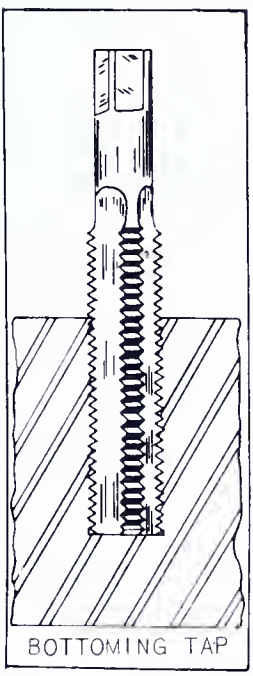


Fig. 73

asily if forced too hard. Be especially careful when approaching the ottom of a blind hole. Small taps will snap off much more quickly than he larger sizes. Getting a broken tap out of a hole is difficult and astes a lot of time, sometimes spoiling the hole completely.

HREADING

Bolts and nuts from 1/4" diameter up to 1" diameter may be hreaded by hand. The operation is performed by using a die, held in

a stock for the bolts, and a tap, held in a tap holder or wrench f the nuts. The mechanic ordinarily speaks of "chasing a thread" on bolt. This simply means cutting the thread with a die and die stoc Threading the nut or a hole in a plate is called "tapping" and is do with a tap and tap wrench.

Bolts and nuts are generally threaded in the machine shop a come to the job ready to assemble. However, it may be necessary "chase" a thread on a damaged bolt. In this case the work is done the shipyard, on the job.

CORRECT HANDLING OF THE TAP AND DIE

THE DIE: When starting to chase a thread on a bolt or ro slightly taper or chamfer the end of the bolt or rod to give the die chance to "start" straight. Better work will result from this pra tice. The die stock must be held square with the center line of t bolt or the thread will "run" to one side and make a bad job. The d will probably "take hold" after a couple of turns, and the bolt shou be lubricated with a little white or red lead.

After the die is on far enough for the end of the bolt to sh through, the die stock should be "backed" slightly to free the cu tings. This is done after every few turns. After the thread has be cut to the desired depth, reverse the direction of the die and run off.

THE TAP: When starting to tap a hole, keep the tap square wi the face of the work, or if the hole is on a slant, keep the t square with the center line of the hole. After three or four turn check the direction of the tap by "sighting" from front and side. satisfactory, go ahead. If the tap "leans", bear slightly on the t to bring it back straight. Be careful to bear easy or the tap wi break. When tapping holes, dip the tap in white or red lead. Lead heavier than cutting oil and will make a smoother thread. Lard oil often used when lead is not available.

TAP SETS

Hand taps are made in sets of three:

Taper--tapered for 5 of 6 threads
Plug--tapered for 3 or 4 threads
Bottoming--corners of leading threads chamfered

PIPE THREADS

Pipe thread taps and dies are entirely different from screw thr taps and dies. Pipe threads are tapered. When it becomes necessary cut pipe threads or to tap holes for pipe fittings, the mechanic sho consult a standard table which may be found in most tool rooms, or fo men's offices.

PROCEDURE

1. Check the size of the tap to be used. The blueprint usua gives the information. If there is no blueprint, check number of threads on the bolt. See Fig. 74 and Fig. 75 getting the pitch of the thread. Measure the O.D. of the bo

2. Get the tap from the tool crib. Ask for a set of taps. For example:

   1/2"- 13 set of three taps (tap sets are never broken.)

   NOTE: Be sure to get a tap wrench to fit the square shank on the cap.

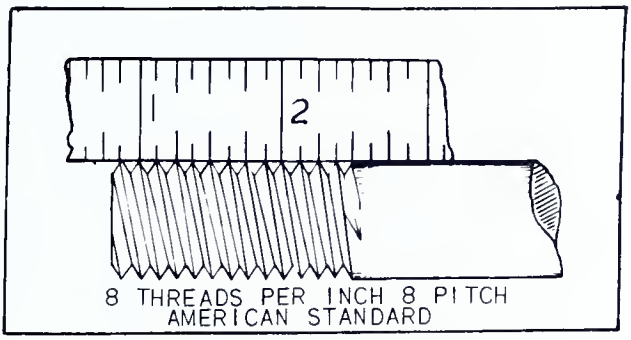


Fig. 74

3. Use a few drops of cutting oil or white lead on the tap if the material is steel.

   NOTE: Use a "dry" tap when tapping cast iron. A little white lead on the shank-end of the tap threads will make the tap work easier in the threads already cut. For brass and copper use turpentine and lard oil. For aluminum use kerosene and lard oil.

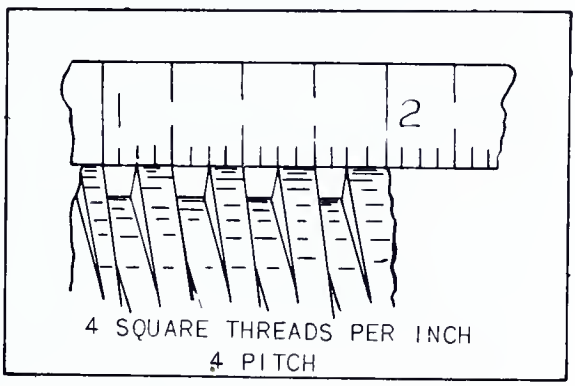


Fig. 75

4. Start the tap square with the work.

5. After two or three turns, "sight" the tap for direction. If satisfactory, proceed.

6. After one or two more turns, back the tap about half a turn and free the chips. Start ahead again.

7. Repeat step 6 until the tapping is finished.

   NOTE: Proceed the same way when tapping a blind hole, except for the use of two taps: plug and bottoming taps.

ES

Hand threading dies come in three types:

1. Dies which are round and fit a round socket in the die stock. The outside diameters of the dies in a set from 1/4" up to 1/2" are the same. Then the next series from 9/16" up may be a larger outside diameter. These round dies are adjustable by means of a screw in the die stock.

2. Dies which are square and in one or two pieces. The two halves of some dies may be adjusted by means of a screw in the die

stock. Other dies are adjusted by means of a screw which carried in one die-half and which thrusts against the ot die-half. These square dies run in a series from 1/4" up, sets that fit certain series of die stocks.

3. Dies which are square and not adjustable (See Fig. 76) are h in a square stock by means of a thumb screw. All dies in series are the same size outside. The threaded portion of die may run from 1/4 - 20 up to 1-1/2 - 6, in series to s the capacity of the stock and handle. The larger the diame of the bolt, the more the leverage required to turn the die the bolt; therefore, longer handles are used on die stocks large dies.

ADJUSTING THE DIES

In using any type of die, the operator may thread the bolt to the nut very snugly or very loose This is done by placing a good tap the die and adjusting the die (if is adjustable) to fit the tap with desired clearance. The instruc will demonstrate how this is done.

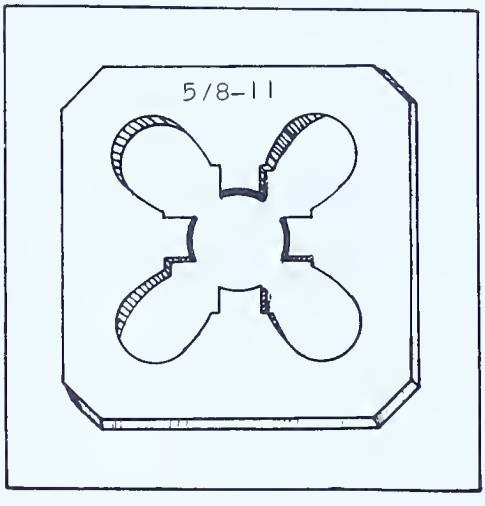


Fig. 76

NOTE: This type of square die has f thread chasers inserted. chasers are made of high gr tool steel for long wear. points "a".

QUESTIONS

1. What is meant by the word "standard" when applied to bolt and nut threads: Commercial? U. S. Navy?
2. State the rule for finding the size across the flat of a nut.
3. What is the dimension across the flat of a 1/2" nut: Commercial? U. S. Navy?
4. Explain what is meant by "tapping" a hole.
5. What tool is used to "chase" a thread on a bolt?
6. Name the three taps generally found in one set.
7. What is understood by the term "blind hole"?
8. Which tap is used for tapping a "through" hole?
9. Why must the tap be started square with the work?
10. What lubricant is used for tapping cast iron?
11. Why is the tap "sighted" for direction after the first few turns?

12. What is meant by the pitch of the thread?
13. Explain the advantage of using white lead on the shank end of the tap when tapping cast iron.
14. Give the pitch of a thread which numbers 16 threads per inch.
15. What is the pitch of a 1" inch diameter bolt, American Standard thread?
16. What is the difference between standard screw threads (National Standard) and Pipe threads?
17. Where may the information be found for the size of the hole to drill for a 3/8" pipe thread?

Tightening a Stud in a Threaded Hole

IFORMATION

Figure 78 shows a stud driver used to tighten a stud (Fig. 77) in a treaded hole. The stud driver is made by drilling and tapping a piece c hexagon or square material to fit the stud on one end and to fit a st screw on the other end.

Installing this stud with a pipe wrench would offer a possibility of spoiling the threads or damaging the body of the stud because the smooth portion between the threads is so short that the wrench jaws would overlap too much.

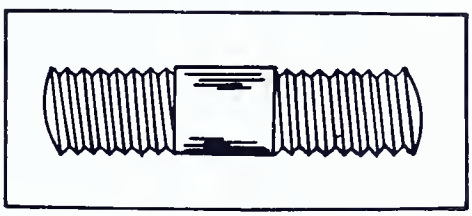


Fig. 77

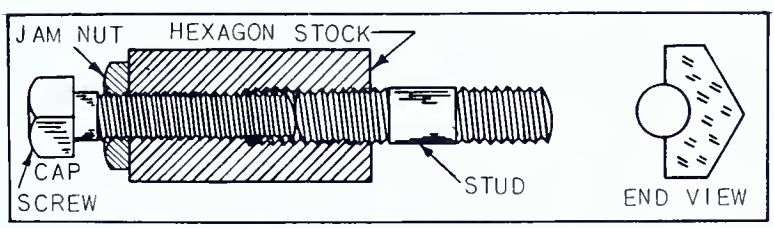


Fig. 78

nding the stud fast in a hexagon piece of stock, as shown, by means of heavy cap screw, permits the use of a large wrench on the hexagon stock to run the stud home securely.

TOOLS

1. Stud driver
2. Open end wrenches

MATERIALS

Stud bolt
Threaded hole
White lead

TIGHTENING A STUD IN A THREADED HOLE

PROCEDURE

1. Examine the threaded hole to determine the size and number of the threads.

   If uncertain, check for number of threads with the thread gauge.

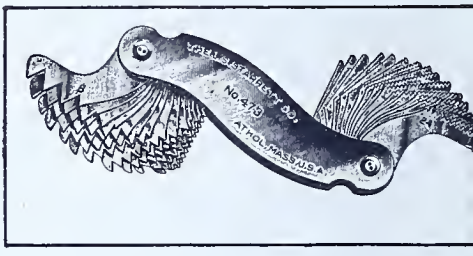


Fig. 79

   NOTE: A thread gauge is a tool which is put up in much the sa form as a thickness gauge except that each leaf is notch out on one edge to match the thread on some particul screw. See Fig. 79. A screw, stud, or bolt may be tri in a threaded hole or in a nut to determine the "pitc of the thread. "Pitch" is another name for the spaci of the threads on a bolt or in a nut.

2. Check carefully to see if the threads in the hole have been ba tered or mashed. If necessary, retap the hole with the prop size tap.

3. Dip the hole end of the stud in white lead or other lubrican Engine oil is sometimes used, and in specific jobs a mixture graphite and oil is used. Lubrication of the threads preven corrosion and makes the stud easier to remove when necessary.

4. Screw the stud in the hole hand-tight. Use care that the fi gers are not cut on the stud threads.

5. Screw the stud driver up on the stud to a length of about times the diameter of the thread.

6. Using the open end wrench, tighten the set screw or locki stud against the stud.

7. With an open end wrench that fits the body of the stud drive tighten stud firmly in the threaded hole. Use judgment tightening the stud so that it is not broken off due to t much strain.

   NOTE: In removing a stud that is hard to start with a stills wrench, two nuts may be tightened together on the end a stud. The stud is removed with an open end wren placed on the nut nearest to the stud hole.

QUESTIONS

1. Why is a set screw used in a stud driver?
2. To what depth is the stud driver screwed on the stud?

3. Why is a lubricant used in placing a stud in a threaded hole?
4. Explain how a threaded hole is examined for fitting a stud.
5. What two precautions must be taken when placing a stud in a threaded hole?
6. How is the correct number of threads per inch determined?

Removing Studs or Broken Bolts

STUDS OR BOLTS BECOME BROKEN OFF

Removing old studs or bolts in the course of overhauling various ces of equipment is sometimes very difficult. The threads are rusted, i the stud or bolt may break under the strain of turning it out the threaded hole. If the broken portion remaining in the tapped e projects far enough, a pipe wrench may sometimes be used and the ken piece backed out. When the wrench fails, two nuts may be locked the threaded end of the stud which projects, and the stud may be ked out. This is only possible where there is enough thread left on stud at the free end.

Where a stud has been broken off flush with a casting and there is way of getting a wrench or backing-out stud-nut on stud to screw it , it must be drilled out or drilled to be screwed out with a tool led an "easy-out". After removing the stud, the hole should be apped to insure a clean thread.

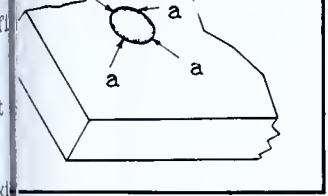


Fig. 80

Smooth the surface of the broken stud, if possible. Put prick-punch marks on the circumference of the stud, as shown at "a", Fig. 80.

n the stud is broken off above the surface as wn in Fig. 81, saw or chip the projecting piece flush with the surface of the work as at "c". e smooth and proceed to lay off the center of the broken stud.

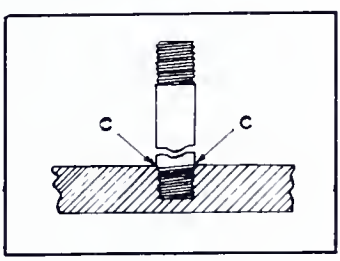


Fig. 81

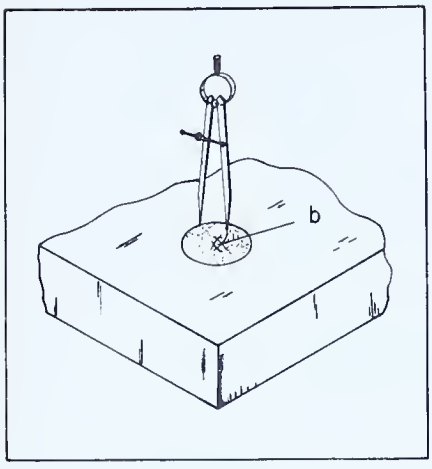


Fig. 82

Place point of divider leg in prick pun mark and scribe arc as close to center broken stud as possible. Take half of t diameter of the hole for the radius of t arc. Center punch as shown at "b Fig. 82.

TOOLS

1. Air drill
2. Dividers
3. Prick punch
4. Center punch
5. Drill
6. Drill sockets
7. Hammer
8. Drift key
9. Screw pitch gauge
10. Set of taps
11. Tap wrench
12. Easy-out
13. Hack saw
14. 10" flat bastard file
15. Gouge chisel

MATERIAL

Chalk

A part in which stud has been broken

PROCEDURE (When using an easy-out)

1. Locate the center of the stud with the dividers. To do thi chalk over the stud and with the center punch, make four equal divided prick punch marks on line, See Fig. 80, showing t circumference of the hole; placing one divider point successi ly in these holes, locate center with the other point. Ma the center with the center punch. See Fig. 82.
2. Drill a through hole in this center. The size of the dri should be approximately two-thirds of the diameter of the st For example: For a half-inch stud, drill a 5/16" hole.
3. Select an easy-out of the proper size and drive it snugly i the drilled hole. See Fig. 83.
4. Back the broken piece of stud out of the hole. Use a close-fitting wrench on the square of the easy-out.

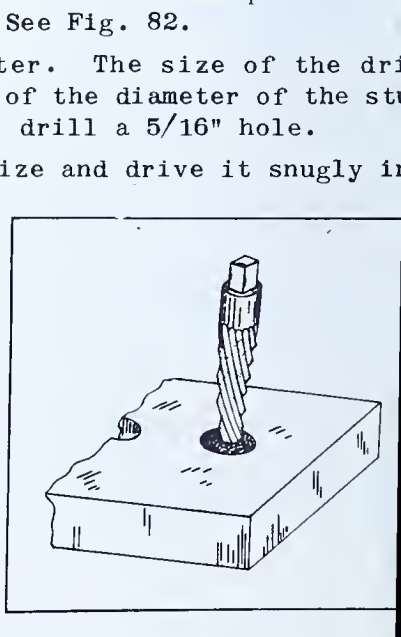


Fig. 83

PROCEDURE (When drilling the broken stud and re-tapping)

1. Locate the center of the stud with the dividers. To do this, chalk over the stud and with the center punch, make four equally divided prick punch marks on the line (see Fig. 80) showing cir-

cumference of the hole; place one divider point successively in these holes. Locate the center with the other point. Mark the center with the center punch. See Fig. 82.

2. Select a drill for this job approximately 1/32" smaller than the root of the thread of the broken-off stud. This is to prevent drilling into and ruining threads in the casting. See Fig. 81.

3. Place the drill in the air motor drill socket. Fasten the drilling post over the broken-off stud and set the drill in the motor, central with the center punch mark in the stud. Start the motor and feed the drill through the stud.

4. To remove the stud shell from the hole, split the shell with the sharp gouge chisel. Tap the gouge point against the shell lightly with the hammer until the shell is removed from the hole.

5. Secure a tap of the same size and number of thread as the removed stud and re-tap the hole by hand. This will remove the burrs made with the gouge.

QUESTIONS AND ASSIGNMENTS

1. Calculate the size of the drill to use in drilling to remove a 3/4" American Standard thread (U.S.S.)
2. With a coin or round end object draw a circle. Locate with a compass the center of the circle.
3. How many threads per inch does a 3/4" U. S. S. tap have?
4. Why must unusual care be used in starting the drill central in a broken stud?

Screw Driver

: OF SCREW DRIVER

A 6-inch and a 10-inch screw driver are generally found to be suit- for ordinary jobs. The blades in these two sizes are about 3/16" 3/8" wide respectively. A screw driver must fill the slot in the w head for the best results. A 3/16" blade should never be used o the work of a 3/8" blade. To do so will result in the screw 's becoming chewed up, making it almost impossible to get a good on the screw slot afterwards. The screw driver will also become y chewed up and twisted. Use the right size for the job.

Using a large screw driver and a small screw is possible, but to his the blade will have to be dressed down to fit. The screw may me twisted off because of too much strain applied by the large w driver. When the screw driver is used on a large screw after lade has been dressed down thin, it will likely snap off.

CORRECT BLADE SHAPE

Figure 84 shows how the blade should fit a screw head slot. flat mill file may be used to dress the blade as shown. The head of the screw will not be chewed up, and less effort is required to run the screws in and out. Screw driver shanks and blades are not hardened and they are easily bent. A bent shank prevents good work.

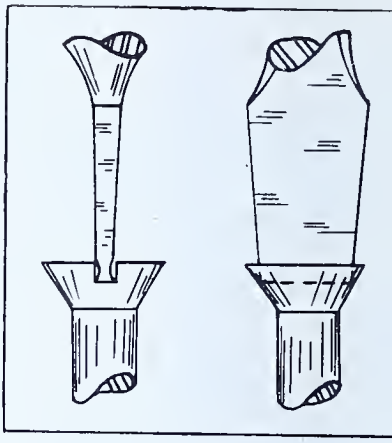


Fig. 84

CAUTION

Do not use a screw driver as a cold chisel. Using the screw driver for a packing tool may not hurt the screw driver, but it is poor practice. Use the tool correctly and it will always be ready for use in its proper place.

QUESTIONS

1. What is the result of using a small screw driver when a larger one should be used?
2. Explain what is done to the blade of a screw driver to prevent the blade from slipping out of the slot.
3. State the sizes of two commonly used screw drivers.

Files

PURPOSE OF A FILE

Files have two very important purposes:

a. Smoothing metal surfaces.
b. Changing the size and shape of metal pieces.

Castings and forgings have fins, burrs, and uneven surfaces w must be filed down smooth before these parts can be used. Appear makes a lot of difference, and a good job can be spoiled by poor fil

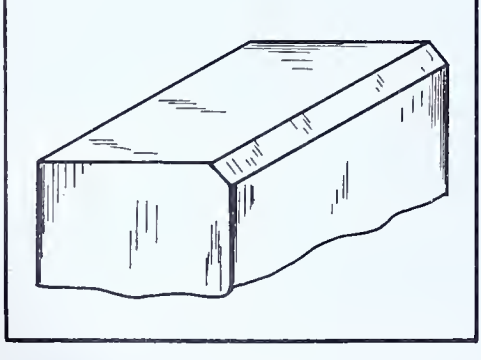


Fig. 85

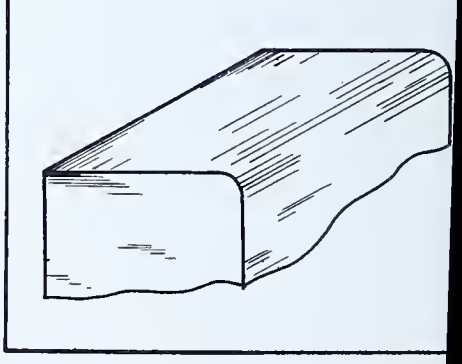


Fig. 86

The machinist must file off sharp corners. Fig. 85 shows a chamed corner. Fig. 86 shows a rounded corner. Burrs on bolt ends, edges steel plates, burrs on drilled hole edges, and many other such othing jobs have to be done.

When the machinist is assembling or installing various units and ts aboard ship, he will have to fit many metal parts into specific ations. Some of these jobs are: Filing chocks, fitting keys, fitting pped operating rods, squaring edges of blocks, and other fitting s.

ES AND SIZES OF FILES

There are a great many types and sizes of files available. As the side machinist uses comparatively few types and sizes, only these es will be mentioned here. Fig. 87 shows the cross section of five es. These cross section dimensions vary in proportion to the length the file, but the shape remains the same.

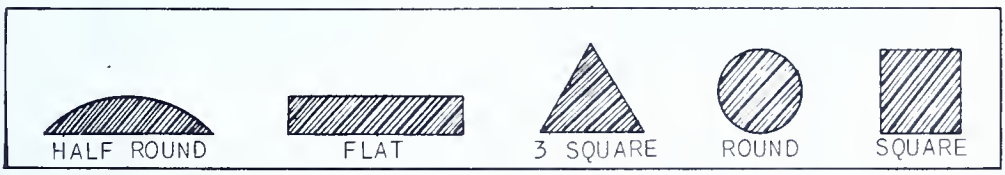


Fig. 87

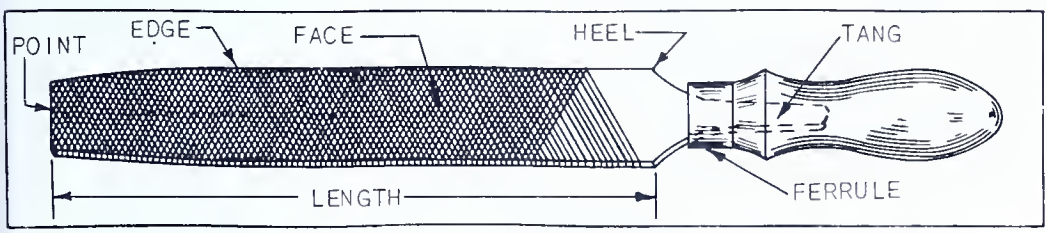


Fig. 88

The length of a file is taken from heel to point. See Fig. 88.

It will be clear from Fig. 88 that the file tapers from about the nter to the point. The faces of these files are slightly "bellied". e reason for this is that it is almost impossible to file a surface at if the file is perfectly straight.

Another reason is that all files are made of high carbon steel and ter being "cut" (explained below) they are hardened. The hardening ocess sometimes results in a slight "draw" or curve in the length of e file. If the files were the same thickness throughout the length, is easy to see that a slight curve would make one side rounding and e opposite side hollow.

LES

Use file handles at all times. See that the handle fits snugly and thout wobble.

Do not use a split file handle or a file handle without a ferrule. unding on a file handle is poor practice. Avoid it.

FILE CUTS AND USES

Files are necessarily rough in order to make them cut. Examinin file closely with a magnifying glass will reveal many fine teeth on surface. These teeth are formed when the file is "cut".

A sharp, chisel-edged, hardened tool in a special machine cuts teeth on a file before the file is hardened. Fig. 89 shows highly larged surfaces of a bastard file and a second cut file.

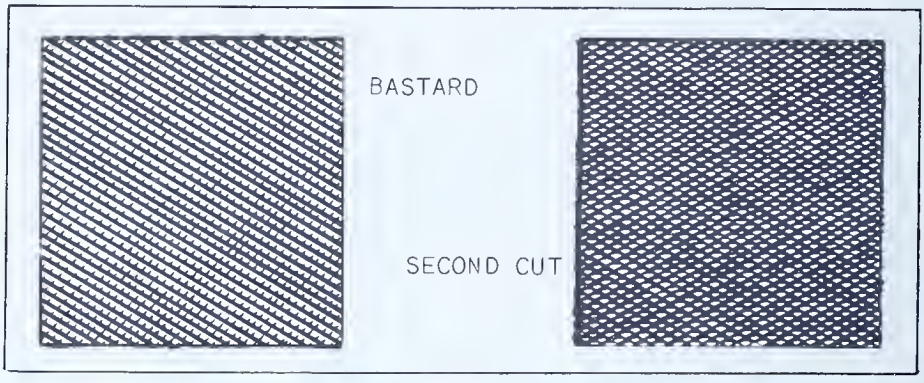


Fig. 89

The names of the cuts indicate the spacings of the teeth rows. bastard file has teeth spaced farther apart than a second cut. The t "second cut" means there are two rows of teeth in about the same dista as one row of teeth on a bastard file. The second cut file is a fi file than a bastard, but not so fine as a mill file.

Both the files named above are "double cut" which means that th are two rows of cuts or teeth on the full length of the file. Look the point or the heel of a file and it is quickly found whether the f is "single" or "double" cut. See Fig. 90.

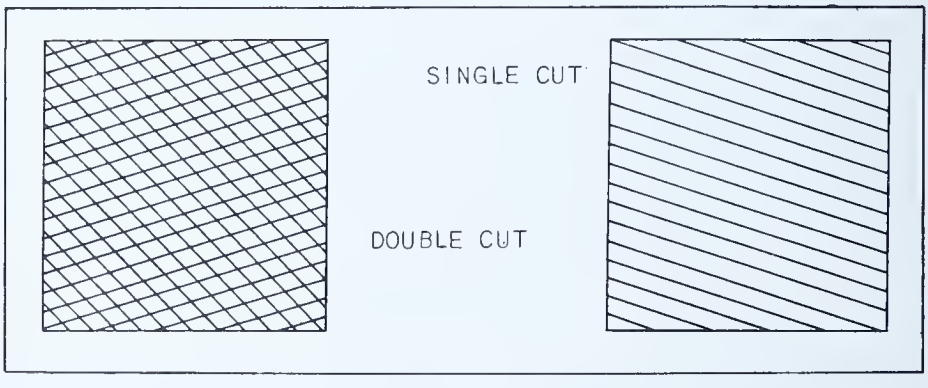


Fig 90

For a finishing job, a flat mill file is generally found to be cellent. Never use a mill file for a rough job. To do so will ruin file for finishing work. A mill file is single cut and the cuts are so deep nor so far apart as in a second cut file. The teeth are cont uous across the width of a mill file and are more like knives in th action on the metal than like small points, as in other files. Dull these knife-like teeth makes the file useless.

Use a bastard file for a roughing job. Use a second cut file for ughing brass or bronze. Finish file all these metals with a mill file. ver use a file on steel or iron and then expect to do a good job on ass or bronze. Keep a file especially for use on brass.

ZE OF FILES

Files are obtainable in lengths from very short to extremely long. e outside machinist files are usually 12" long. The width and thick- ss depend on the length. When asking for files at the tool crib or if rchasing files say, for example:

12" bastard, flat or half round
14" flat, second cut
14" mill file

RE OF FILES

Do not throw files around among other tools or on the deck. Step- ng on a file just right will break it. Remember files are hardened d therefore brittle.

Keep the file clean on the job. Oil is of no value on a file. It events cutting, and it "gums" the spaces between the teeth. When a le "pins" (becomes choked with filings), clean it with a file brush a stubby piece of copper wire flattened out like a chisel. Allowing file to pin, especially a mill file, will ruin an otherwise good job scratches and deep cuts.

Never use another man's file without permission. He may have a ecial job to do which requires the use of the file you have borrowed.

QUESTIONS

1. For what purpose or purposes are files used?
2. Name some of the jobs which require the use of files.
3. State the types of files which are usually found to be satisfactory for the work of the outside machinist.
4. In roughing off burrs or fins, what type of file should be used?
5. Why does the mechanic keep one or two files especially for use with brass?
6. Explain the type of job for which a round file would be used.
7. Name one or two jobs where a half round bastard file would be very useful.
8. What type of file should be used to finish off the surface of a 3" x 4" steel block level and smooth?
9. For what purpose is a square file generally used?
10. What are two safety rules to follow when using a file?
11. What effect does oil have on the correct use of a file?
12. Explain the cause of "pinning", the results, and how to prevent it.

Fitting a Key

INFORMATION

The word KEY is the name given to a piece of metal, usually steel, which is employed to lock two parts of a machine together as solidly as though the job was made out of one piece. Fig. 91 is an end view of a coupling and a motor shaft showing how the keyway is half in the hub and half in the shaft. Note carefully that the keyway position and size are always given on the blueprint and must be strictly followed.

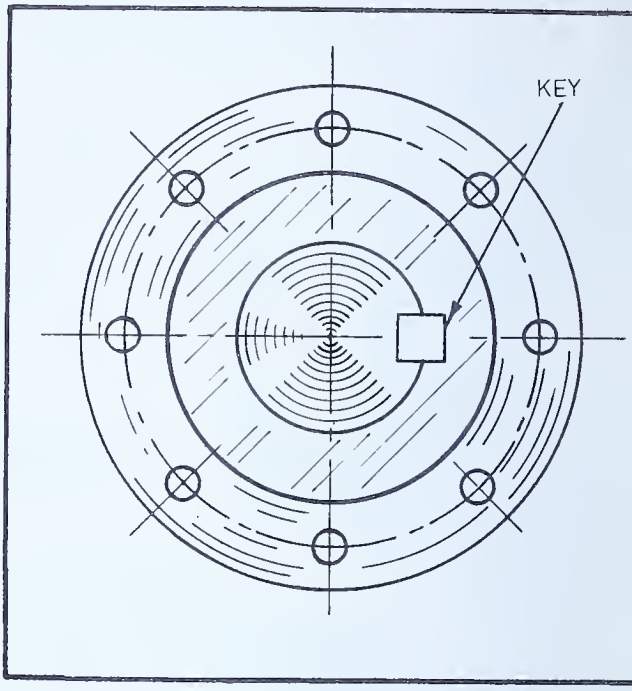


Fig. 91

CUTTING KEYWAYS

Keyways are usually out in the machine shop. The parts to be keyed together are brought to the ship with the key or keys partly fitted to the job. Keyways can be, and at tim are, cut by hand but this is unusual. In either case the fitting of t key is about the same.

SHAPE OF A KEY

Keys may be straight or tapered. See Figs. 92 and 93. A taper key drives in more tightly and of course is a little easier to fit th a straight key. Some keys are fitted tightly on all four sides a others are fitted on three sides. The fi ting is done with a mill file. See t leader for full details.

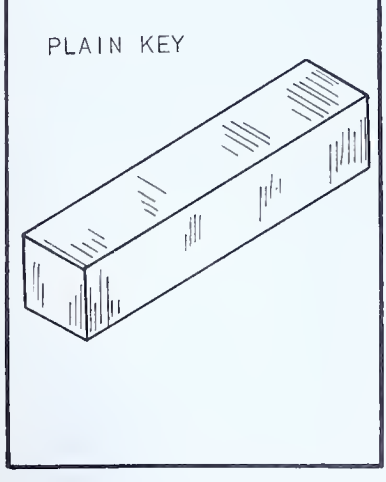


Fig. 92

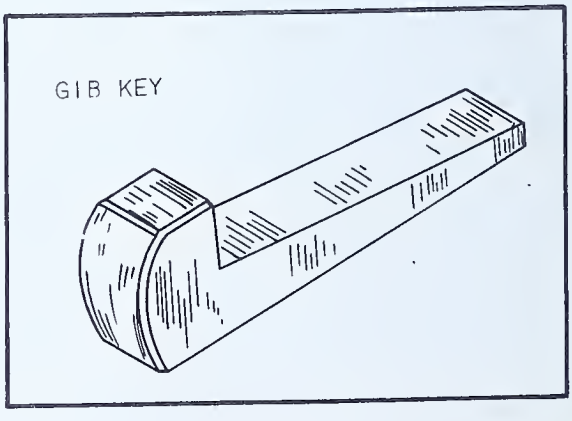


Fig. 93

ZE OF KEYS

Keys may be any size from 1/4" up to 1" square in ordinary jobs. rger keys are installed in heavy units such as a propeller and prop- ler shaft.

Some keys have a head as shown in Fig. 93. This makes it easier remove the key by driving a drift behind the head and drawing the y out. This feature is found on many tapered keys.

TTING THE KEY

1. Remove the sharp corners from the key.
2. Remove any burrs that may be on the edges of the keyway.
3. Try the coupling on the shaft for fit. If not satisfactory, check with the leader. If the fit is correct, proceed.
4. Try the key in place to check the fit.
5. Dress high spots on the key, if any.
6. Check with the leader.
7. Apply white lead to the key and keyway when correctly fitted.
8. Check the coupling for correct position on the shaft, endwise.
9. Drive the key home to the correct location. Check with leader.

QUESTIONS

1. To what extent is the keyway prepared to receive the key when the job is delivered to the yard?
2. What tools are needed to fit ordinary keys?
3. How can the correct fit of a key be determined?
4. Explain the difference between a square key and a taper key.
5. What is the advantage in using a taper key?

Miscellaneous Hand Tools

ERATION WITH TOOLS

The mechanic does not use all of his tools on any one job; nor es he use them all in any one day. The tools should be at hand to use en necessary. The tools which have been mentioned in the instruction terial so far are probably used more than any others in the tool kit tool crib. A few general instructions on how to use various other ols will be considered in this section.

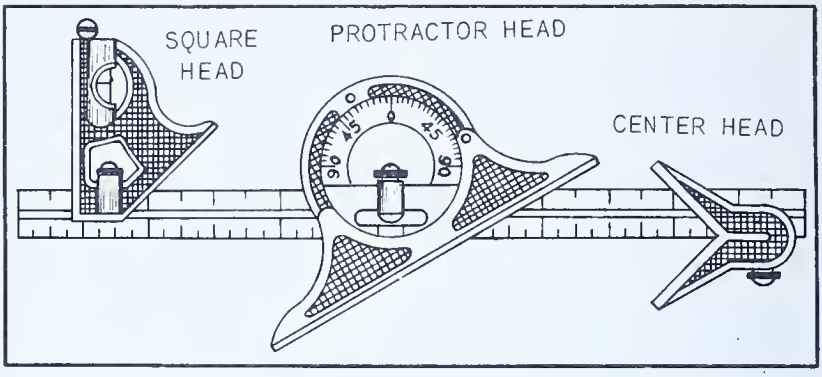


Fig. 94

COMBINATION SQUARE

Figure 94 shows a tool which consists of four parts. The squa head, Fig. 95, may be used with the blade to scribe lines at rig angles with an edge or surface. When the blade is used with the pr tractor head, Fig. 96, lines may be laid off from a straight edge surface at any angle up to 180 degrees. When the blade is used with t center head, Fig. 97, a line may be scribed exactly across the cent of a piece of round stock like a shaft end.

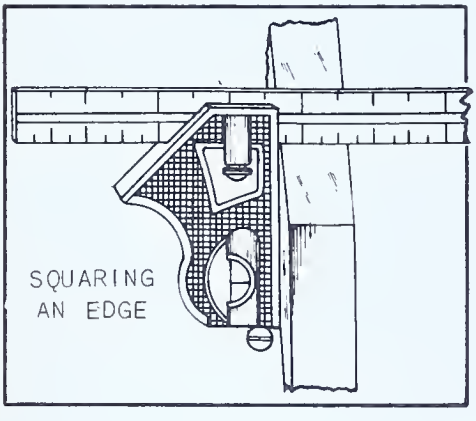


Fig. 95

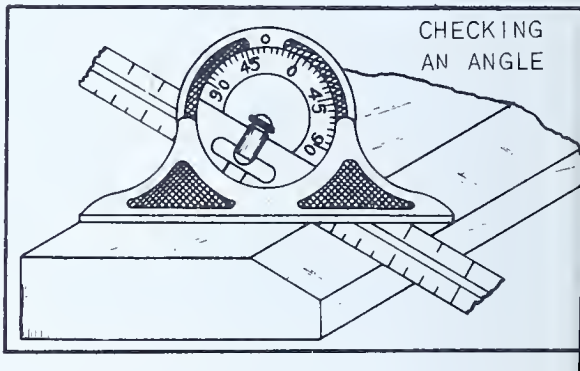


Fig. 96

The blade is a scale which may be used for measuring as with any other scale. The size of the combination square depends on the length of the blade. The heads of the tool are made in proportion to the length of the blade. Combination sets usually have a 12" or 18" blade. Do not drop the tool, for a fall or blow will destroy its accuracy.

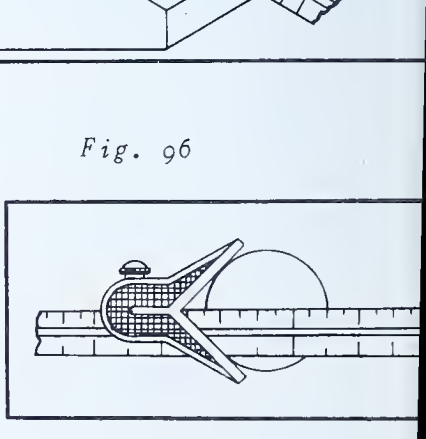
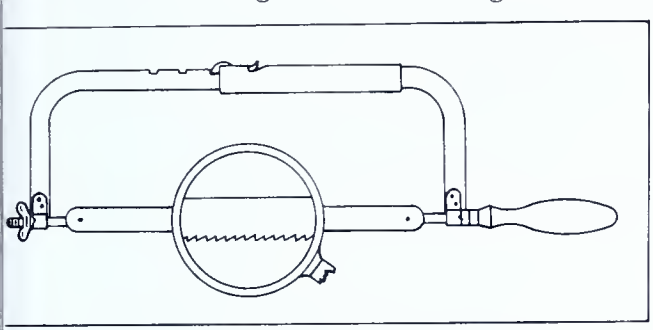


Fig. 97

HACK SAWS

Hack saw frames are made adjustable to take blades 8, 10, and 14 inches long. See Fig. 98. A 12" hack saw blade is usually a c

ient length for ordinary use. The teeth are spaced either fine or rse and are designated according to the number of teeth per inch.



NOTE: Some hack saw handles are made with a "pistol grip".

Fig. 98

K SAWING

1. Keep the blade under the correct tension. Ask the leader how the first few times, to avoid breaking the blade. He will help adjust the tension.

2. Hold the saw straight across the work and make even strokes from toe to heel. (The instructor will demonstrate this.)

3. *Do not saw fast.* Fourteen strokes to the minute are plenty.

4. *Do not bear down too much.* Too much pressure will "strip" the teeth or "bow" the blade until it breaks.

5. Ease up slightly on the return stroke. The work is done on the "push" stroke.

6. When sawing thin stock or tubing, use a fine-toothed saw.

7. Coarse-toothed saws are better for soft stock or wide material. Fine-toothed saws plug up in soft material.

8. Do not allow the saw to "bind" in the cut. Follow a vertical line when sawing downward. If the saw is not held "easy" in the cut, it is easily broken.

These are only a few of the many precautions to observe when using ack saw.

N SNIPS

The tin snip is really a sheet metal worker's tool, but it is very eful on many outside machinist jobs. See Fig. 99. Some of the prin-

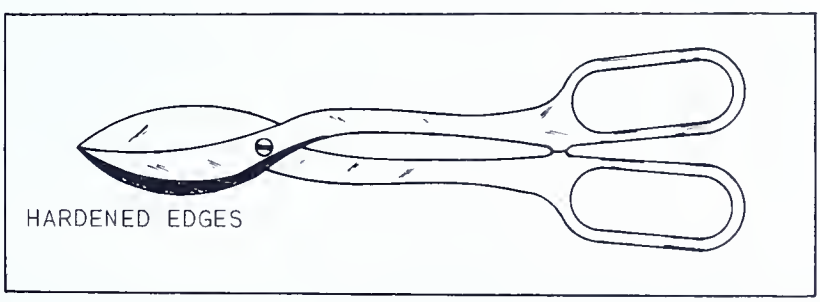


Fig. 99

cipal uses for tin snips are cutting gasket material, sheet metal t plates, soft wire, copper screening, etc.

Never cut hard wire, large nails, or small rods. Tin snips l their "shear" when employed on work that is too heavy. The instruc will explain what is meant by "shear". Hard wire nicks the cutt edges, making it impossible to cut thin materials satisfactorily. snips come in several sizes and styles. Use the correct type and s for the job.

KNIFE

An ordinary pocket knife is a very useful tool for trimming gaske cutting packing, trimming wooden packing sticks, etc. Keep the kn sharp. A dull tool is a nuisance. See your leader for the best type knife to buy.

SCRIBER

Tool steel is necessary for a good scriber. See Fig. 100. point must be kept sharp at all times. Using the scriber is like us a pencil. The difference is that a scriber will make a fine line, larger than a hair. A dull scriber is worse than none. Close work be done only when a fine line is used to do the marking. The scri point is sharpened on an oil stone. Never use an emery wheel. (instructor will demonstrate some of the ways to use a scriber.) pocket scriber with a reversible point can be carried in the pocket.

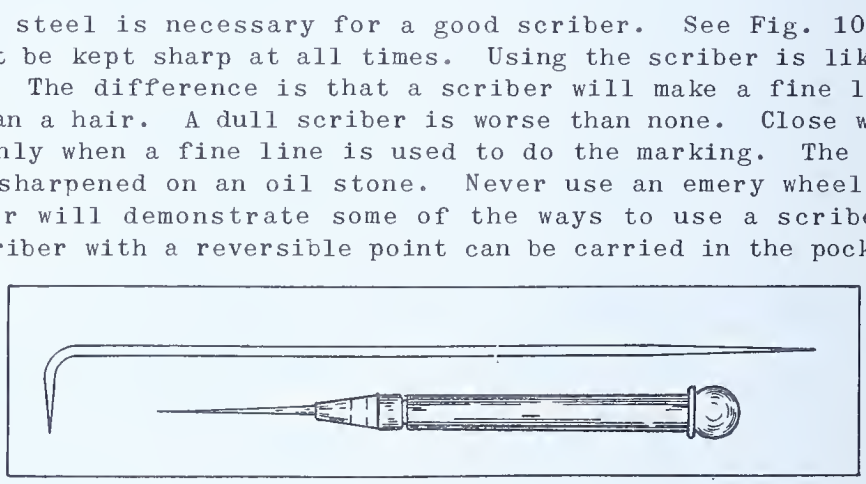


Fig. 100

LEVEL

The outside machinist uses a level (See Fig. 101) on many jobs, only while the ship is on the ways. Some of the jobs set with a l are:

Setting deck stands; leveling the "horse" on the after end of eye in the stern frame when running a line; and setting overboard charge castings in correct position on sea chests.

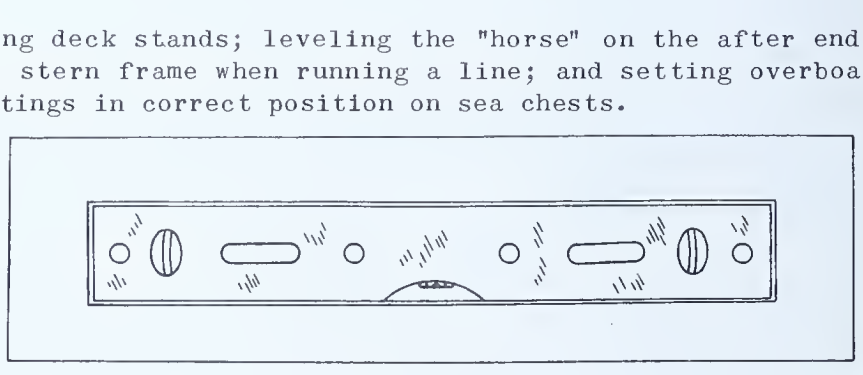


Fig. 101

When the bubble is exactly between the two hair lines on the gl the surface upon which the level rests is level. Some levels have

"glasses" and the level may be used to plumb a perpendicular. (The instructor will demonstrate the uses of a level.)

There is a level glass in the square head of a combination square. The head and blade may be used for a plumb, or the head alone may be used for a level on short surfaces of a job. Always use the longest level possible, for accuracy. Levels are made from 6" to 24" long.

PLUMB BOB AND LINE

In long, vertical distances where a point several feet below must be lined up with a fixed point above, a level is out of the question. In this case we use a long chalk line, which is a heavy cord, with a weight on the bottom end to hold the line taut. See Fig. 102. The weight is called a "bob", and the line is then known as a "plumb line". As the illustration shows, the plumb bob is pear-shaped with the small end hanging down. The small end is pointed, and in using the plumb line there must be no "swing".

The point of the plumb bob will hang directly over the location when the upper end of the line is held on the mark at the top side. A location at the top of the work may be laid off from a point below by means of the bob, but it is usual to work from the top down. After the line has been located, it is possible to take measurements, using the plumb line as a center line and measuring off in any direction at right angles to the plumb line. (The instructor will demonstrate the use of a plumb bob and line.)

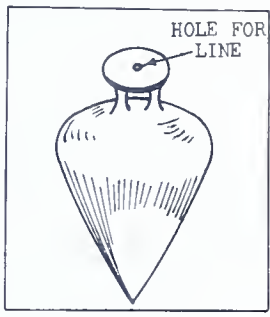


Fig. 102

THICKNESS GAUGE (FEELERS)

The thickness gauge is a tool which consists of several very thin leaves". The illustration, Fig. 103, shows the ordinary type of thickness gauge group. The leaves are very accurately ground and generally re grouped together, the individual leaves measuring from .0015 up to 015. The tool is called "feelers" because the small spaces measured an be "felt" instead of being seen.

The other leaves, of thicknesses in between these two dimensions. ay be used in groups of two, three, or more to make up any desired hickness, the total amount being the sum f the thicknesses of the leaves used.

One of the principal uses of the thickness gauge is to check the accuracy of a hock when fitted between a foundation and he base of a pump or motor which is being nstalled. Another use is the checking of he clearance between the rotor and stator f an electric motor. The thickness gauge ay be used to check the clearance between ump impeller and the housing.

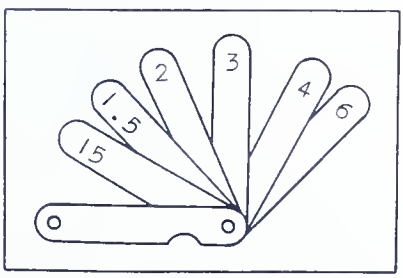


Fig. 103

ADJUSTABLE WRENCH

While the use of an open end wrench is always preferable to that of n adjustable wrench, very often an adjustable wrench is more convenient n the job where there is room to use one, (adjustable wrenches are

usually thicker than an open end wrench) because the adjustable wrench may be quickly changed by a thumb nut to fit a half-dozen different nuts. See Fig. 104.

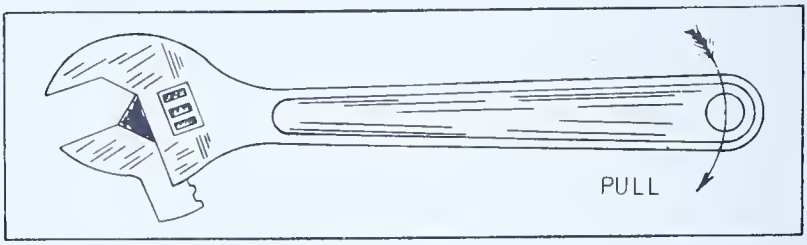


Fig. 104

One very bad feature of the adjustable wrench is that it will slip off the nut much more easily than an open end wrench if it is not constantly watched. The adjustable jaw wears in the groove, and then the jaws do not fit the nut tightly. In putting a strain on the wrench always pull in the direction shown in the illustration.

Never use an adjustable wrench as a hammer. Keep the adjusting-nut, headless machine screw tight at all times. The screw has a tendency to work loose and when it does, there is nothing to retain the adjusting nut. The result is a useless wrench. The instructor will demonstrate the correct way to use the wrench, point out its ordinary uses, and show how to replace a broken jaw.

STILLSON WRENCH

Stillson wrenches, see Fig. 105, are used almost entirely when screwing pipes in or out of a coupling or other type of fitting. These wrenches may also be used to get a grip on any cylindrical piece of material within the limits of the wrench opening. The jaws of the wrench have hardened teeth which help grip the piece securely and prevent slipping. The jaws grip tightly only under the pull on the handle. If the direction of the pull is reversed, the wrench must be turned around to face the other way. Stillson wrenches are not to be used on finished surfaces or on a thermowell when installing a thermometer.

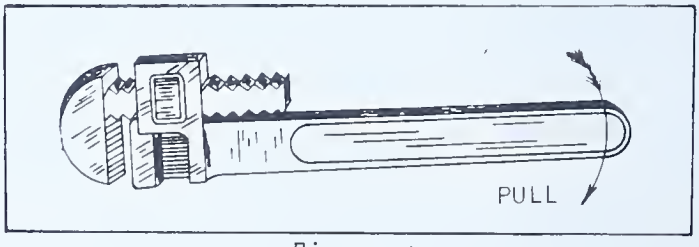


Fig. 105

A stillson wrench, because of its sturdy construction and long handle, may be used to put a slight bend in fairly heavy material, such as a plate or a flat bar. Always ask the instructor if in doubt as to where to use this wrench.

MONKEY WRENCH

A monkey wrench is quite similar to a stillson wrench. See Fig. 106. There are no teeth on the jaws, and the wrench may be used to exer

essure in either direction without reversing the wrench on the work. monkey wrench always holds to the work better when the direction of e pull is away from the back of the wrench. Pulling the other way has endency to spring the jaws open and cause the wrench to slip.

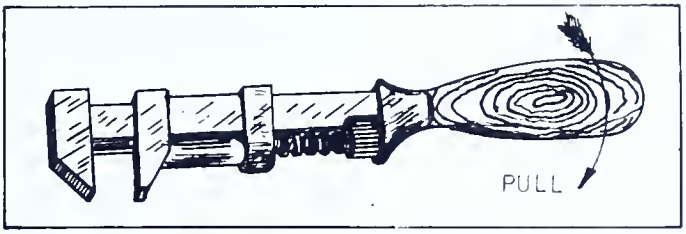


Fig. 106

A monkey wrench may be closed up tightly on a steel bar of up to lf inch in thickness and a fairly good right angle bend made in the ck. This is not possible with any other type of wrench. For certain ght and medium light work, a short piece of pipe may be placed over e handle of the wrench to get extra leverage.

When a really heavy job has to be done, get a "ouija Bar". There no use in destroying a wrench by putting too much strain on it. he instructor will demonstrate some ordinary uses of a monkey wrench.)

IERS

The usual type of pliers used by the outside machinist are "side tting". See Fig. 107. The hardened steel cutting edges are used to t soft wire (steel or copper), small nails, screws, and so on. The at nose allows the tool to be used in a fairly narrow place to "nip " to a wire or other piece of material and pull it out.

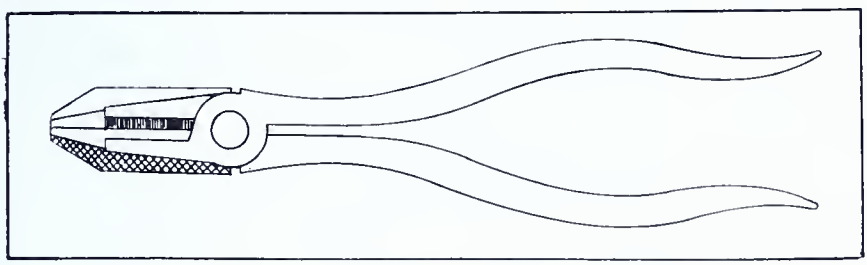


Fig. 107

The jaws are usually serrated (finely grooved), and the pliers may used to "crimp" thin sheet metal. The serrations keep the jaws from ipping. (The instructor will demonstrate different ways of using ers.)

It is not good practice to use pliers to tighten or loosen nuts. a wrench. Never use the cutters to cut hard wire. When the cutters e nicked they are useless.

POINT BOX WRENCH

The 12 point box wrench is a very important tool to use in cramped aces. See Fig. 108. The illustration shows how the wrench may be aced on the nut in 6 different positions. A box wrench of this type y be used to tighten a nut where no other wrench can be used.

NOTE: Nuts on some jobs must be tightened up very snugly to prevent any possible loosening. It is permissible to put a short piece of pipe over the handle of the wrench and pull the nut up snugly.

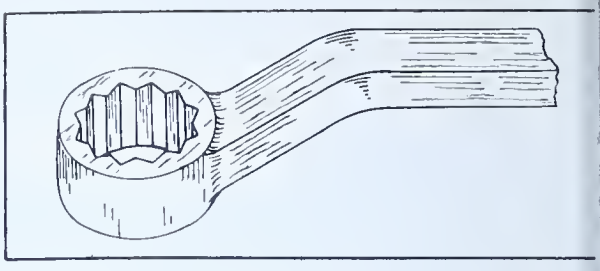


Fig. 108

CALKING TOOLS

Calking tools are generally used in an air hammer. The calki tool has a round shank which fits the air hammer tool holder. Rivet seams between plates and between angle supports and plates are "calke (hammered along the edge) to make an extremely tight joint.

The outside machinist will not have a great amount of calking to do, but he should know how the tool is used. Very often the mechanic may save a lot of time by calking a job at once instead of waiting for calking crew to do the work. Fig. 109 shows two types of calking tools. Some tool noses are smooth and some are corrugated. The instructor will demonstrate the use of the tool.

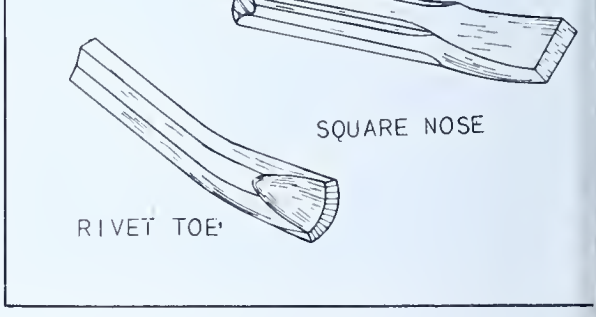


Fig. 109

FOX WEDGES

Figure 110 shows a fox wedge. The wedges are usually 3-1/2" lon 3/8" thick at the butt end, and about 1" wide. Very often a hand ho or an inspection cover has to be removed, or a coupling has to be "br ken" (separated at the flanges) without injuring the machined surface Using a cold chisel, a screw driver, or any other such tool will resu in damage to the job. ALWAYS USE A FOX WEDGE for these jobs.

The thin end of the wedge is dressed to nothing and should be ke that way. The wedge is made of tool steel and hardened. It should n be thrown around carelessly, but should be kept wrapped in a cloth or otherwise protected from becoming burred or nicked. The wedges are usually 3-1/2" long, 3/16" to 3/8" thick at the butt end, and about 1" wide.

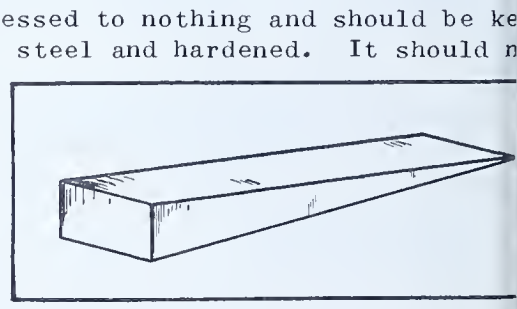


Fig. 110

LK LINE

A chalk line is a heavy, woven cotton cord. Keep the chalk line the tool box when not in use. Chalk lines are used to line up eys on ice machines, and to "snap" a line on the deck or bulkhead. ising the line, chalk it well; and holding one end at a certain point, etch the line taut. Pick the line up about midway between the two nts and let go sharply. The line will snap to the original position leave a chalked line on the surface of the work.

FTS

When two plate edges lap each other and have holes the edges for rivets or s, the holes are lined up sticking a drift through holes and working the t sidewise until the holes drawn into line, so that a rivet or bolt may be pushed through an ining hole. There are many sizes and lengths of drifts. See Fig.

Fig. 111

Drifts may be used to guide a motor or pump base to the exact lo- on on a foundation by slipping the drift through the hole in the and inserting the drift point into the hole in the foundation.

THE HAND SCRAPER is a flat piece of steel very much like a section and saw blade, but without any teeth. The scraper is from 2" to 4" and 6" long. The edges are perfectly straight and smooth. The s are kept to a keen cutting edge by rubbing on an oilstone. The ructor will demonstrate the use of this scraper for straightening ings.

THE FLAT SCRAPER and THE BULL NOSE SCRAPER are made from worn out s and ground to shape. See Figs. 112 and 113. The edges must be very sharp to do good work. The bull nose is used to scrape ves smooth and to clean out bearings. The flat scraper is used for ning joints. The instructor will demonstrate the uses of these pers.

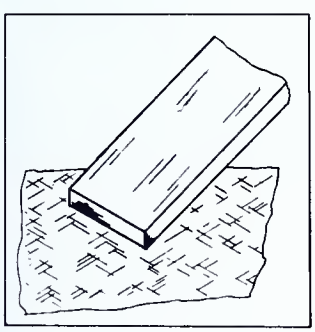


Fig. 112

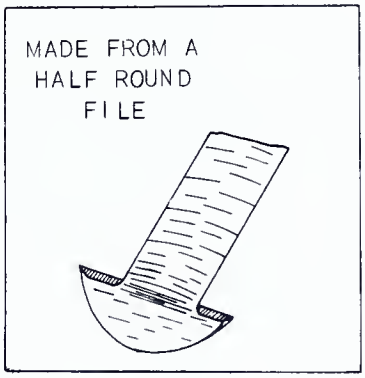


Fig. 113

THE THREE CORNER SCRAPER is used for scraping the burrs from the s of oil grooves, for cleaning out oil grooves, for chamfering p corners on small work, and other similar jobs. See Fig. 114. A out three square file makes a good three corner scraper. If the

scraper is bent at a slight curve it may be used to better advantage i many places. The instructor will demonstrate the use of the thr corner scraper.

THE STRAIGHT SCRAPER is made from a discarded half round file, be at a slight curve, and ground. See Fig. 115. This scraper is used f scraping out bearings while the bearings are being fitted to a shaf The scraper is sometimes known as a "spoon" scraper. The edges a kept sharp by rubbing with an oil stone. The instructor will demo strate the use of a straight, or spoon, scraper.

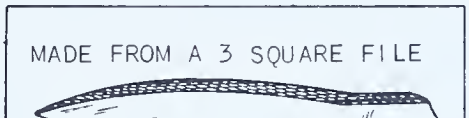


Fig. 114

Fig. 115

STRAIGHT PACKING HOOK AND
SCREW PACKING HOOK

A STRAIGHT PACKING HOOK, see Fig. 116, is a very useful tool i digging packing out of a deep stuffing box. When the packing has bec old and dry, it is very difficult to remove it with a straight hoo Then the SCREW PACKING HOOK is used. See Fig. 117. The screw hook i be used the same as a cork screw and the packing pulled out with v little trouble.

Some straight packing hooks have a bend at the point. See Fig. 1 This bend forms a foot which may be used to stuff the packing tigh into the stuffing box. This is a distinct advantage when loose pack is used. The bend also serves to pull the packing out of a stuff box. The instructor will demonstrate the use of these packing hooks.

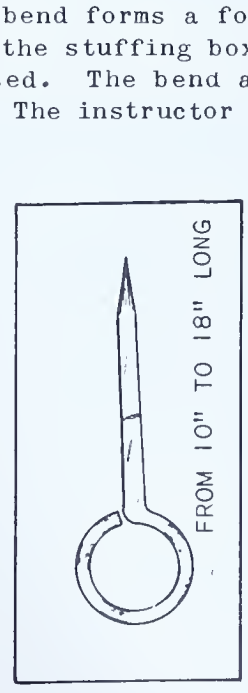


Fig. 116

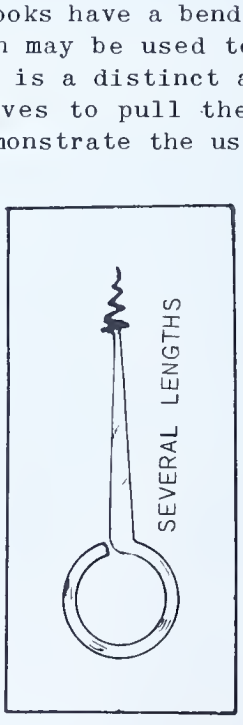


Fig. 117

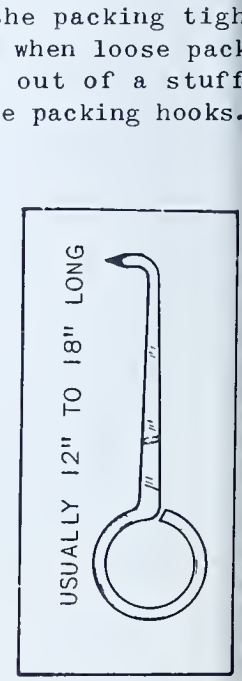


Fig. 118

FT PUNCH

When it is necessary to remove a tightly fitted pin from a hole, er use a center punch to do the job. The point of the center punch l be ruined if the pin is hardened, and also there is a tendency to arge the end of the pin and thus make removal more difficult. Use a ft punch. See Fig. 119. A drift punch is made of good steel, not ily bent, and ground to a square point. The body of the punch is ger than the punch point.

When driving out a , use a punch that nly slightly small- han the pin. If it a tapered pin, be rned by the size of small end. Drift ches are made with drift end from 1/8" o 3/8" and are long or short to suit the job.

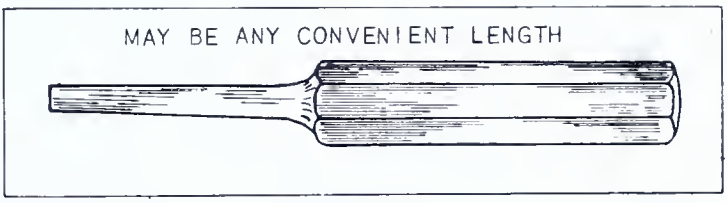


Fig. 119

GLES

Always use an approved type of goggles. These are equipped with ter-proof glass and side shields. When the machinist is grinding or ping, a good pair of goggles will prevent eye injury. Goggles may secured from the tool crib. It is better to be safe than sorry. safety rules.

STONE

Oil stones are furnished by the tool crib. They are usually fine ne side and coarse on the other. Use a little light oil on the stone n wetting a scraper or when sharpening dividers, trammel points, scribers. The stone is also used to remove nicks and rust spots. l stones are used to smooth gear teeth.

AGON SOCKET WRENCH

These wrenches are sometimes made in the shop by cutting off a e of pipe and forming one end to fit a hexagon nut. Holes are lled through the other end for a rod, to use as a handle. See . 120. The length of the wrench makes it possible to reach into places not easily done with another type of wrench. While these ches are very useful, they will not withstand so heavy a strain as socket wrenches mentioned in the next paragraph.

This end of the e has been heated formed to shape r a piece of hexagon k of the correct size.

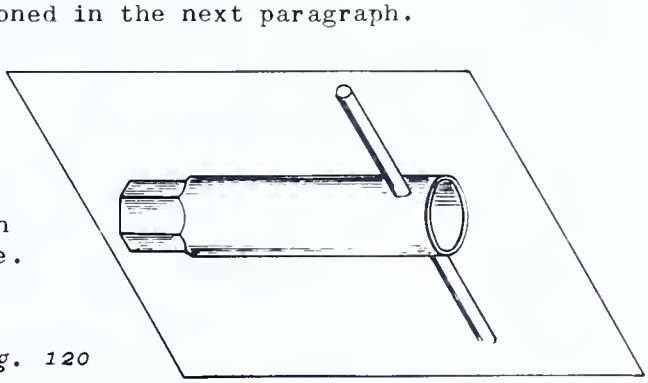


Fig. 120

SOCKET WRENCHES

These wrenches come in sets of six or more sockets, a ratchet handle, and an extension to reach into deep places. See Fig. 121. The wrench sockets are forged and will withstand a good, strong pull. The advantage of a socket wrench is that the nut is not damaged; neither will the wrench slip off easily. Never use a hammer on a ratchet handle.

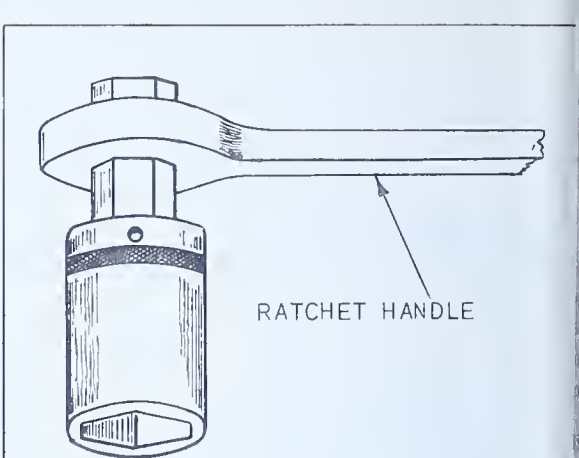


Fig. 121

HEXAGON BOX WRENCH

This is much the same as a 12 point wrench but has only six points of contact with the nut. See Fig. 122. In a narrow space, t hexagon box wrench may be used to better advantage than a socket wrenc The socket wrench works well in a deep pocket. Allen wrenches are us where hexagon socket-type set screws are used. A special wrench must used for turning this type set screw. See Fig. 123.

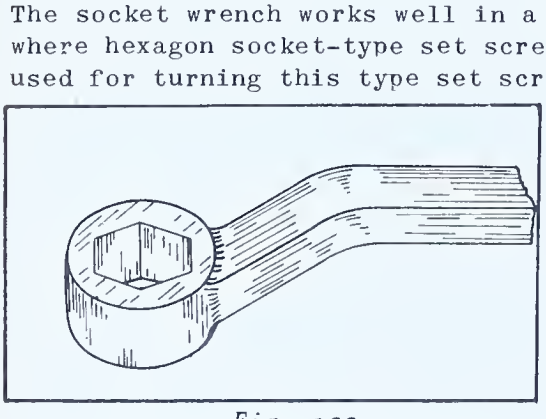


Fig. 122

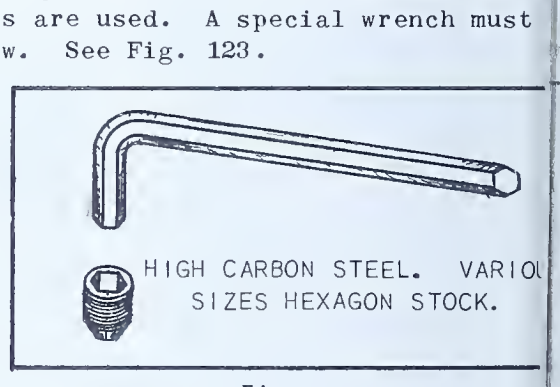


Fig. 123

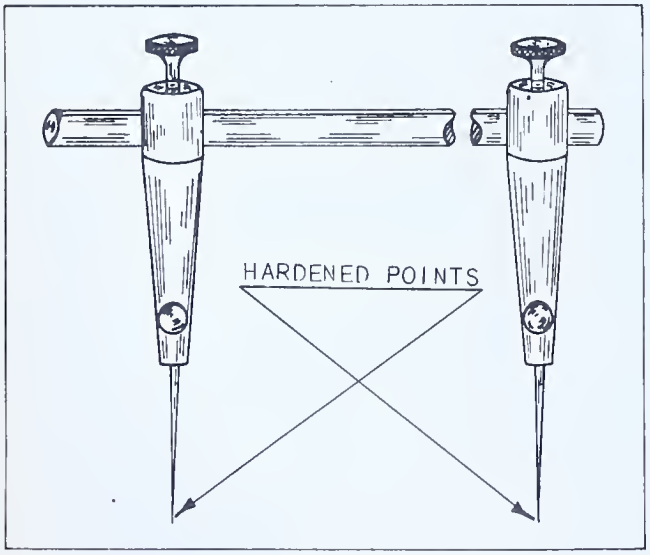


Fig. 124

TRAMMELS

Trammels are used place of dividers where t scribing leg must stand right angles to the work. Fig. 124. There are sever sizes and styles of tramm which make it possible to into many different pla that would ordinarily be h to reach.

The beam is a good gr of steel. The points are t steel, hardened and temper The points are kept sharp using the oil stone. Lar unusually shaped trammels kept on the job until the w is finished.

Trammels are useful in measuring distances that are pre-determined y marking the correct distances with prick punch marks. The trammel egs are then adjusted so that the points register exactly in the prick unch marks. The measurement thus obtained may be transferred to the ob. These prick punch marks are known as "tram marks".

When fitting chocks, place tram marks on the base and foundation, rectly in line, and as the fitting proceeds, use the trams in the prick unch marks to check the distance for accuracy. Any difference in the eight of the base from the foundation, all around the job, is quickly oticeable. One leg trams are used for special jobs. The instructor ill demonstrate many uses of trammels.

TRAIGHT EDGE

While a six-inch scale may be used as a straight edge on small jobs, here are many times when the scale will be unsuited to the job. A traight edge is true and level for the entire length. Because much de- ends on the accuracy of a straight edge, the tool is made of material hat is not likely to spring or change shape. Cast iron, machined very ccurately, has been found quite satisfactory. See Fig. 125.

Never drop a straight edge. Never pile other material on a straight dge. Keep the machined surfaces oiled to prevent rust.

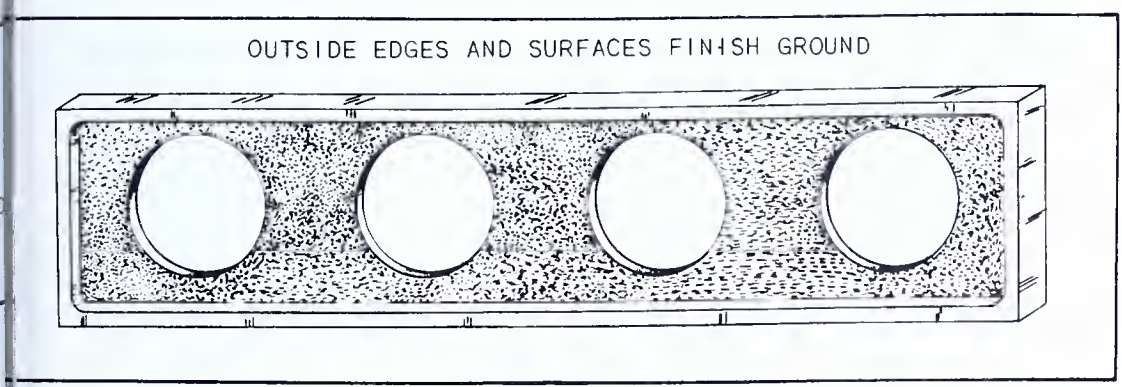


Fig. 125

Straight edges are usually kept in the tool crib, but some me- hanics prefer to keep their own straight edges.

QUESTIONS

1. Explain the difference between the purposes for which di- viders and calipers are used.
2. Name two measuring jobs performed with outside calipers.
3. What tool should be used to scribe a line at right angles to the edge of a steel plate?
4. Name the two types of files which are used mostly on out- side machinist jobs.
5. Explain the difference between straight flute and spiral reamers and point out the principal uses for both reamers.

6. What type of wrench is used to the best advantage on general work?

7. For what purpose is a center head and blade used?

8. Explain the use of the tool which is generally employed to locate a point on the inner bottom of the ship directly below a point on the weather deck.

9. What is the name of the tool which is used to test a surface that is supposed to be vertical?

10. When the packing in a stuffing box has hardened and will not come out easily, what type of packing hook may be used to loosen it up?

11. Explain the advantage of a 12 point box wrench.

12. For what purposes are trammels used?

13. What size wrench opening is required for a 3/4" standard hexagon nut? Commercial? U. S. Navy?

14. Explain the difference between a stillson wrench and a monkey wrench.

15. State the way a fox wedge is made and the purpose for for which it is generally used.

16. What type of socket wrench is made in the shop?

PART II

OUTSIDE MACHINIST TRAINING
ADVANCED WORK AND MAINTENANCE

PART II

Using a Portable Grinder

RPOSE OF A PORTABLE GRINDER

A portable grinder is used, wherever possible, to expedite the work the outside machinist. Uneven surfaces on foundations, rough edges plating, excess stock on chocks, and rough spots on decks or bulkads are ground smooth with the portable grinder.

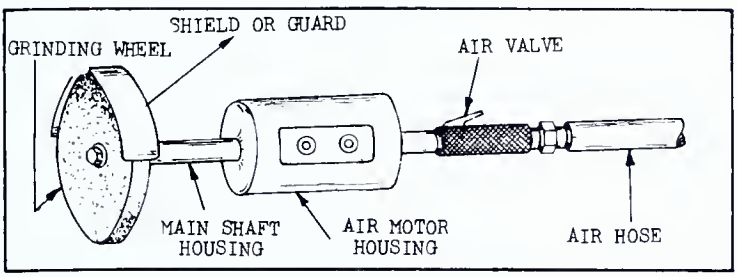


Fig. 126--Portable Grinder

E AIR MOTOR

The tool is driven by an air motor which receives a steady supply compressed air through a heavy rubber hose attached to the handpiece the grinder. Fig. 126 shows an air valve at "a" between the hous- and the air hose. The position of this air valve makes it easy for operator, by a touch of the thumb, to admit or cut off the air in- ntly.

RATING THE GRINDER

When grinding, the operator must keep his hand on the air valve stantly; for when the valve is released, the wheel stops.

The other hand is placed to grasp the neck between the grinding eel and the motor housing at "b" to guide the machine over the work. er a little practice, the operator will discover the correct way to nd to hold a balance and guide the grinding wheel.

When using the grinder, the operator does not need to "lay on" the hine to make it grind. If too much weight is applied, the wheel will w down and consequently less work will be accomplished. A steady, n pressure while the machine is kept moving slowly back and forth l remove stock quickly and do a smooth job.

INDING WHEELS

The grinding wheels used are about 1-1/4" to 1-1/2" thick and 6" 8" in diameter.

Be careful to use a wheel of the correct grade and grit for the . The grade of wheel used for steel is not generally used for cast n. Check with the leader about the correct grade of wheel to use.

CLEARING THE LINE

Before attaching the air hose, clear the line by turning on air at the main valve. This will blow out any dirt or water that have collected in the line. If the motor slows up or sticks, application of a little light machine oil will clear the valves. connect the air hose from the hand-piece, replace the air hose, and out to clean the mechanism.

SAFETY PRECAUTIONS

When the grinder is laid down on the deck, never move the air trol valve. To do so may cause the machine to roll around and pos drop through an open space which could result in serious injurie others.

Never hook up a machine and then raise or lower it by means o air hose. The coupling could let go, or the air hose might b either could have serious results.

MAKING REPAIRS

Never attempt to take a portable grinder apart if it seems to repairing. Such work is always done in the tool room by experts. port to the leader at once if the machine fails to work properly.

QUESTIONS

1. Name a few jobs where a portable grinder is used.
2. Why is the machine called a "portable grinder"?
3. How is the action of the air motor controlled?
4. Where does the operator place his hands when he is using a portable grinder?
5. Explain how the line is cleared before the air hose is attached.
6. Who makes the decision regarding the correct type of wheel for the job?
7. Explain how the operator can control the grinder to make it work best.
8. Name a few safety precautions which should be observed when using a portable grinder.
9. What should be done when it seems that the grinder needs repairing?

Fitting Chocks

PURPOSE OF A CHOCK

The installations aboard ship, such as electric motors, t generator sets, cargo pumps, etc., must be bolted down to the deck or support provided by the ship erector. All this machinery has lined exactly with the center line of the ship and, within certain l level, as the ship rides normally. As the decks and foundations a exactly level or "fair", some method has to be employed to make t chinery level and true.

OCATION OF CHOCKS

Rectangular blocks, usually cast iron, are placed between the some-hat irregular and uneven surface of the foundation on which the equip-ent is to be placed and the base or pedestal of the equipment installed. he full weight of the equipment is distributed among supporting chocks, hich must therefore be carefully fitted so that when the ship is riding n the water, vibration will not cause the chock to move and the equip-ent to shift and lose its alignment. The shape of a chock and the anner in which it is used are shown in Fig. 127.

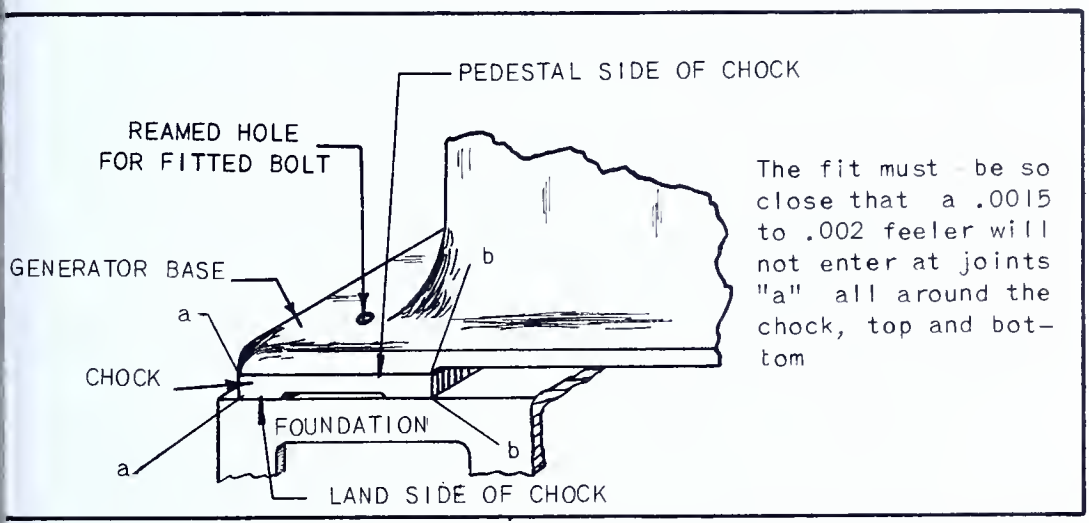

PEDESTAL SIDE OF CHOCK
REAMED HOLE FOR FITTED BOLT
GENERATOR BASE
a
b
CHOCK
FOUNDATION
a
b
LAND SIDE OF CHOCK
The fit must be so close that a .0015 to .002 feeler will not enter at joints "a" all around the chock, top and bottom

Fig. 127--Fitted Chock Between Base and Foundation

AFETY

Watch the movements of other workmen to avoid injury to them or to ourself.

Take care of the tools and equipment in use on the job, so that ey do not fall and injure some other workman.

Be careful not to trip over the many cables, hose lines, and other eces of equipment which are always found around the job.

OOLS

1. 6" scale
2. Inside calipers, 8"
3. Files: 12" bastard, flat
   12" mill, flat
4. Portable grinder
5. Outside calipers, 6"
6. Chock puller
7. 1-3/4 pound hammer
8. Thickness gauge

MATERIALS

Chock sheets
Blue chalk
Marking paint

ENERAL PROCEDURE

1. Line up the motor, pump, or other equipment, using steel blocks and wedges under the pedestal. Check with the level and declivity board on some machined surface of the unit being installed. Adjust blocking until the unit is level.

NOTE: Large, heavy jobs require the use of jacking screws blocks and wedges to move the unit sidewise or endwis (The jacking screws are welded to the deck and burn off after the job is finished.) Jacking screws are al used to move the heavy jobs up and down.

The holes that are in the base of the unit may tapped, or a hole may be drilled in the base and tappe A large set screw and a half nut may then be used jack the unit up and down as required.

(When the job is ready for the installation of t hold-down bolts and the location of these bolts com in a tapped hole, the hole must be re-drilled in ord to remove the thread in the tapped hole. It is alwa difficult to fit a bolt tightly through a threaded hole

2. With the unit set correctly, drill the deck or foundation f hold-down bolts by lining up the drill in the air drill machi through the hole already in the pedestal. Use an "old man" steady the air drill machine.

3. Measure from the under side of the pedestal to the foundatio *one corner at a time*, beginning with corners "a-a" at the le side. See Figs. 127 and 128.

NOTE: Measure the distance with inside calipers, and read t measurement in 64ths on the scale. See Fig. 22.

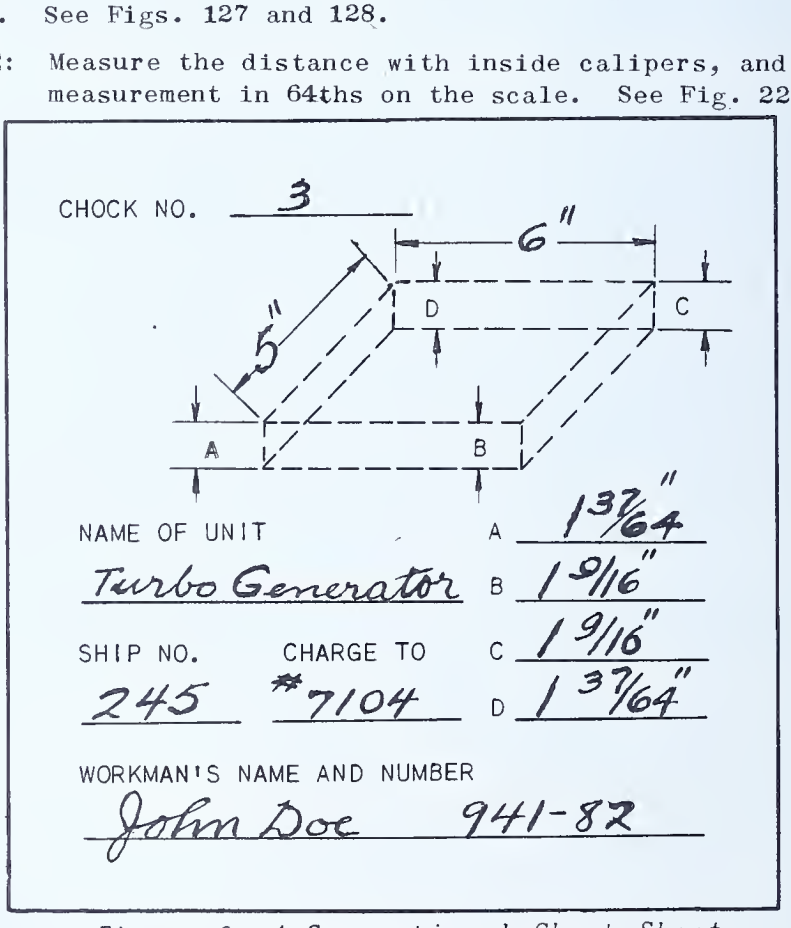


Fig. 128--A Conventional Chock Sheet

4. Continue measuring from the under side of the pedestal points "B","C", and "D", shown on the chock sheet. Do this w

each chock location, and fill out a chock sheet for each chock. Give the size of the chock, the name of the unit under which the chock is to be fitted, the number of the ship, and the charge number. Blank spaces are provided on the chock sheet for this information. Sign the sheet, giving name and clock number.

NOTE: Number the chock sheets with pencil and the chock locations with paint as soon as each measurement is completed.

5. Send the chock sheets and the chocks to the machine shop, where each chock is cut to approximate size, numbered, and returned to the job.

6. Proceed to fit the chock as follows:

(a) Check the chock for size before starting to fit. (Sometimes chocks are spoiled by too much machining in the shop. Do not waste time trying to fix such chocks. Return them to the machine shop to be worked over for another location where a thinner chock may be used.)

With the portable grinder, carefully rough-finish the surface of the chock which rests on the deck or foundation. (This side is called the land side.)

(b) Chalk the land side of the chock.

(c) Slide the chock under the pedestal. The high spots will show up. Slide the thinnest side of the chock under first. Mark the position of the chock to make sure that the fitting is being done in the same place each time. Try feelers at intervals.

NOTE: Since the top side of the chock is a finished surface to contact the finished surface of the underside of the machine base, under no circumstances is the pedestal side to be ground or filed. A portable grinder may be used to remove the high spots from the land side when there is too much to file.

After the mechanic has fitted a few chocks, experience will guide him in future fittings.

(d) Place the chock on a suitable support, and file high spots with a 12" or 14" flat or square bastard file.

(e) Try the chock in place to cause the high spots to show up, as before.

NOTE: Repeat this operation until the chock fits almost all the way in.

(f) Finish-file with a 12" or 14" flat mill file.

NOTE: The chock must fit so that a .0015 to .002 feeler will not enter the joint on either top side or land side.

(g) With the chock fitted correctly (check with the leader), proceed as follows:

(1) Drill the hold-down bolt hole through the chock.

(2) In some cases the chock is carefully held i correct location and the outline of the ho scribed on the chock.

(3) The chock is then removed, the hole outline is m with the prick punch, the center is marked wit center punch, and the job is sent to the machine for drilling.

NOTE: When the machinist is fitting generator chock fits the four corner bolts for driving in. The corner holes in the unit being installed are r after drilling. In some cases the chock is r at the same time. Ream the holes to the size on the blueprint. The bolts are turned larger than the hole, for a drive fit.

All other holes are drilled to size, and bolts usually are large enough to drive in wi fitting. Bolts which are secured from the room and which are not turned to size are c "black bolts" because they are not polished are used in the same condition in which the received from the manufacturer.

(4) Drive the special bolts into place, and draw the down securely.

NOTE: When the machinist is fitting pump chocks, he the holes to size. Black bolts are usually to be a snug fit.

(5) Check fit with .0015 feeler, between chock and plate or foundation, and between chock and under of pedestal.

NOTE: In some instances after the unit is installed an chocks fitted and bolted down, dowels are inst in opposite corners. See Fig.275. This is only where fitted bolts are not used. Check the leader for instructions.

QUESTIONS

1. Why are chocks required under the base of a unit being installed?
2. Explain how a unit should be leveled before the holes are drilled in the foundation.
3. For what purposes are dowels used in the base of the unit?
4. State the correct procedure for installing the dowels.
5. Under what conditions are dowels not necessary?
6. How close should the fit be between the chock surface and the unit base; the chock surface and the foundation?
7. Where are fitted bolts used when installing a unit?
8. How are the high spots indicated on a chock?
9. How much larger than the hole should the fitted bolt be?
10. Explain how to use a chock sheet.

*Using Gasket Material and Thread Dope

YPES OF PACKING

In mechanical work it is of paramount importance that exactly the ight type of packing be used for each individual application or job. emperature, pressure, and the action of the liquid material contacted ave to be considered. Many types and brands of packing are listed in upply catalogs. No attempt is made here to judge any one brand to be etter than any other. Where gaskets are used, the surface of the metal hould be thoroughly clean.

ECIAL MATERIAL

Red gum or rubber packing is used extensively in low pressure water ines working under low temperatures. 1/8" thickness is by far the most ommonly used. 1/16" thickness is available and may be used in joints here the flanges are too close together to admit 1/8" thickness. Greater thickness than 1/8" is never satisfactory either as a ring joint or full joint. One word of caution--if the bolts are pulled excessively ight, the packing flattens and creeps out, protruding all around the lange edges. Since the packing is meant for low pressure work, such xcessive tightening is not called for, and this condition need not ccur.

Wire inserted rubber packing and cloth inserted rubber are excellent in water pipes working under high pressure or hot temperatures. The loth inserted type makes a good gasket for a shell-of-the-ship joint uch as an overboard discharge valve or a clapper valve. The wire and he cloth give the packing a sturdy base, and it will stand extreme ightening without creeping.

OMPRESSED PAPER PACKING

For oil piping a compressed paper gasket material is used, such as ydraulic or kidskin packing. This type of packing, as well as rubber, s also used in low pressure water lines. It may be used as a ring or full joint and is easily cut with a pocket knife. It will stand any mount of tightening. The paper comprising the construction of this acking is in thin layers.

HEET STEAM PACKING

In low pressure steam lines, a great number of brands of sheet steam acking are carried in stock, any of which are satisfactory. Order without using the brand name: for example, 1 piece of steam packing, thickess by width by length. One-sixteenth thickness is preferred in joints hat face squarely and are not pitted. 1/16" cuts easily with a pocket nife. Steam joints should be graphited to prevent the gaskets sticking o the flanges. Heat from the steam after some time causes the gasket o stick so tightly that it will tear if the joint is disconnected and ill be difficult to clean off.

Steam packing that has been treated with graphite lubrication can e obtained. In the majority of cases in low pressure lines, however, lain sheet steam packing is used; and flake graphite, mixed with linseed oil, is applied to each side of the gasket before inserting between the flanges. This graphite lubrication should also be applied to he bolt threads to prevent welding of the bolt and the nut from heat.

In high pressure steam lines more care must be exercised in sel ting the type of packing to use. Most high pressure flanges have bos which necessitate the use of ring joints. See Fig. 130. Only the hig grades of sheet steam packing should be used.

FLEXATALLIC GASKETS

Flexatallic gaskets must be purchased ready made. They consist an asbestos ring covered with a thin metallic composition. On two si a thin, narrow strip of the metal extends out far enough so that two the flange bolts pass through it and hold the gasket in place. Th gaskets are used on high-pressure, super-heated steam lines.

METALLIC GASKETS

Metallic gaskets are ready made to fit. There are different mal the majority of which are corrugated ring joints. Their use is so times specified for high pressure steam lines. (Metallic gaskets used in diesel engine starting air lines where the pressures are high.) Garlock metallic gaskets are used exclusively in some shipya

ASBESTOS SHEET

Asbestos sheet packing is an excellent heat resistant. Differ compounds of asbestos are used extensively in superheated steam lin The exhaust piping from diesel engines requires asbestos sheet pack because of its high working temperature. This packing is obtained sheet form, ready made ring joints, or full joints.

Refer to Crane Catalog No. 52 for information on gasket materia

SUGGESTIONS IN CONNECTION WITH THE USE OF GASKETS

1. Be careful when using a ring joint between cast iron flan because the flanges may crack if the bolts are pulled tight.
2. Do not use a ring joint between two thin flanges because t will dish if the bolts are pulled too tight.
3. Do not use a ring joint in brass flanged joints because brass flange dishes quite easily. Use full joints.
4. Do not use a ring joint where the flanges are exposed to weather, such as on deck. Rust will soon form in the sp from gasket edge to flange edge and deeply pit the flange.
5. Do not use a ring joint where studs are used if there is pressure on the back end of the studs, that is, waterti bulkheads.
6. Use ring joints extensively in all places not exempted ab because they tighten more readily and hold tight better t full joints, eliminating danger of leaks around the bolts.

THREAD AND GASKET DOPE

A mixture of a small amount of red lead powder with one bottle gaskalac forms the most commonly used thread and gasket dope. The lead powder acts as a base, makes the mixture firmer, and causes it dry more quickly. When used on threads, the solution reduces frict of metals and allows the joint to be pulled tight. It also seals joint watertight when it hardens.

LEAD PUTTY

To a quantity of white lead, add red lead powder until the desired sistency is obtained. The more powder used, the thicker the mixture omes. This dope has many uses, such as seating commodes, doping mmets and gaskets on shell-of-the-ship joints, and putting gaskets in gh surface joints where the pressure does not exceed 15 pounds.

HARGE AND GLYCERINE

In some shipyards, all thread joints are doped with expando exsively. This comes in the form of powder and is mixed with water. harge and glycerine is a quick-hardening mixture and should be pred for immediate use. It is used extensively in ice machine, amia, and fuel oil fittings. Pour glycerine into a small, clean conner, and "stir in" desired quantity of litharge. Have joints perfly grease-free and clean. Apply freely to male thread and tighten ckly before the mixture hardens. Moving the fitting after this mixe hardens ruins the joint.

PASTE

Key paste comes ready-mixed in red and blue tubes; one color of is for threads, and the other color of tube is for gaskets. These tures are used in brass fittings and are recommended by the U.S.Navy.

TE LEAD

White lead paste is often used on the gasket in shell-of-the-ship nts. *Caution: Because it is poisonous, white lead should be placed y on the male threads of connections that carry drinking water.* n heating connections close to the thread, as on short bends, use te lead freely on the pipe thread and in the fitting, except drinking er fittings, so that the thread will not tear when unscrewed.

OTH-ON

Smooth-On is an iron cement used for patching broken castings as el as for joining new, old, or worn fittings. It should be used only low pressure fittings. It comes in powder form and is mixed with ugh water to form a paste. Joints must be thoroughly cleaned before plying the mixture. Three or four hours should be allowed for the ture to harden before pressure is turned on.

QUESTIONS

1. Name some of the different types of packing used in shipyard work.
2. Red gum or rubber packing more than 1/8" thick should never be used. Explain why.
3. Where is compressed paper packing used?
4. What type of packing is used for steam lines?
5. Explain why ring gaskets should not be used under certain conditions.

6. Under what conditions is red lead putty used?

7. Where is white lead used?

8. State the qualities of a litharge and glycerine gasket dope.

9. Where is key paste used?

10. Explain where and how Smooth-On is used.

*Adapted from "Shipyard Outside Machinist" by State Department of Ed tion, Alabama.

*Making a Full Face Gasket

INFORMATION

A gasket is a ring or disc of packing used to make a flanged j tight against leakage. See Fig. 129.

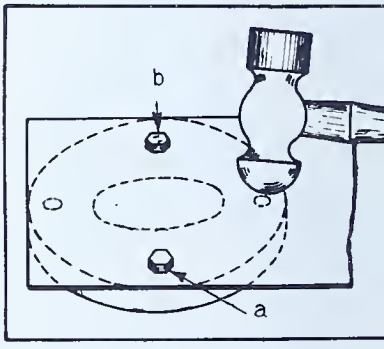


Fig. 129-Cutting Holes with a Hamme

TOOLS

1. Machinist hammer
2. Pocket knife

MATERIALS

Flange
Gasket material

PROCEDURE

1. Lay flange face up and cover completely with gasket mate
2. With the pressure of the thumb, locate a hole in the fla
3. With the ball head of hammer, tap the gasket material ove around the edges of one hole, making the hole edges ir flange cut the material.
4. Place a bolt in this hole so that it will not slip o place. See "a", Fig. 129.
5. Locate and cut the opposite hole.
6. Place a bolt in this hole to prevent the gasket material slipping. See "b", Fig. 129.
7. Locate and cut the remaining holes.
8. With the flat head of the hammer, tap the material over th side and outside edges of the flange, tapping only hard e to make the flange edges mark the material.
9. Remove material from flange face and cut the outside c as marked.

10. Cut the inside circle approximately 1/8" smaller than the mark. This is to cover the thickness of the pipe wall where it comes flush with the face of the flange. If the pipe is extra heavy, the hole should be cut approximately 1/4" smaller.

QUESTIONS

1. Do the holes and edges of the gasket correspond exactly to the holes and edges of the flange face?
2. Why must the gasket fit perfectly?
3. When are standard gaskets used?
4. Where are standard gaskets obtainable?
5. What tool is used to trim gaskets to size?
6. State the usual thickness of gasket material.
7. Explain the difference in the materials from which gaskets are made.
8. What happens when a flange joint is pulled up tightly on a gasket that is thicker than necessary?

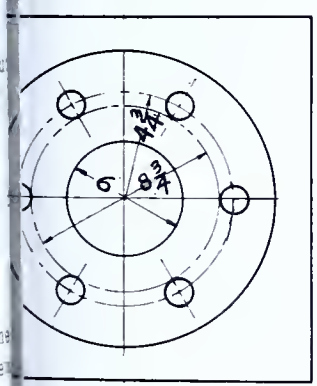
pted from "Shipyard Outside Machinist",by State Department of Educa-
n, Alabama.

*Making a Ring Gasket for a Standard Six-Inch Flange Joint

ORMATION

Ring gaskets should be used wherever possible. See Fig. 130. They ten more readily and hold better than full face gaskets, eliminating danger of leakage around the bolt holes. The instructor will ex- n the reason for this.

The outside diameter of the ring gasket should equal the diameter he circle made by the inside edges of bolt holes. The center hole eter should equal the center hole diameter of the pipe used.



ig. 130--A Ring Gasket

Bolt Circle is 9-1/2 inches Diameter

Bolts are 3/4" Diameter

Outside Diameter of Ring Gasket is 8-3/4 Inches

Inside Diameter of Ring Gasket is 6 Inches

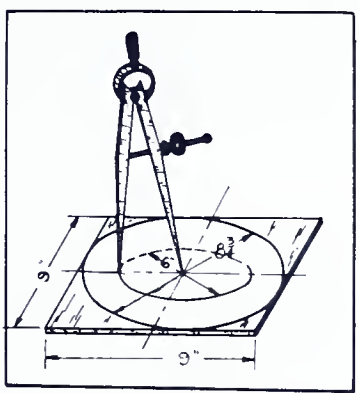


Fig. 131--Laying Out a Ring Gasket

S

MATERIALS

1. Dividers
2. Rule
3. Pocket knife

Gasket material 9" x 9"

PROCEDURE

1. Open dividers until they measure 4-3/8" between points.
2. Place one point in center of material and press down so will not slip.
3. With other point, mark a circle on the material 8-3/ diameter. See Fig. 131.
4. Close dividers until they measure 3" between points.
5. Using same center, mark another circle on material diameter. See Fig. 131.
6. With the pocket knife cut out the gasket as marked.

QUESTIONS

1. Does the center hole of the gasket fit the center hole o a standard 6" pipe?
2. Place the bolts in the holes of the 6" flange. Does th gasket fit snugly within the circle of the bolts?
3. State the places where a ring gasket should not be used.

NOTE: In many shipyards, standard size gaskets may be ob tained from the store room. These gaskets fit al standard jobs. There are some jobs that are no standard. In such cases a special gasket must b made.

*Adapted from "Shipyard Outside Machinist", by State Department of cation, Alabama.

*Cutting a Dovetail Gasket

INFORMATION

There are times when a gasket must be installed without rem a shaft from the bearings. Suppose a gasket has to be renewed for reason, for example, where a shaft passes through a watertight bul This may be done without tearing down any part of the unit exce remove the bolts from the flanges and slide the flange back. In case the gasket is "dovetailed" to slip over the shaft. See Fig.

The Dovetail Is Cut In a Standard Gasket of the Correct Diam- eter

TOOLS

1. Outside calipers
2. Knife
3. 6" scale, or longer if necessary
4. Machinist's hammer
5. Dividers
6. Pencil

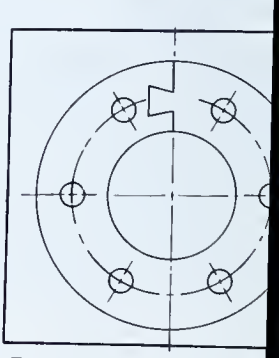


Fig. 132—A-Dove Gasket

EDURE

1. Measure the inside and outside diameters for the gasket.
2. Obtain a standard gasket from the storeroom.
3. Lay the gasket on a flat surface and find the center with the dividers.
4. Lay one edge of the scale on the center, and scribe a line across the diameter of the gasket.
5. Lay off a dovetail at one side of the diameter as shown in Fig. 132.

Fig. 133--Installing a Dovetail Gasket

6. With a sharp knife cut the dovetail through accurately. See that there are no ragged edges.
7. Now slip the gasket over the shaft and close the dovetail in place.
8. Use a machinist's hammer to locate the bolt holes.

   NOTE: If there is not enough room to use a hammer, lay out the bolt-hole circle and carefully space the holes. Scribe the hole circle with the dividers, and cut out with a sharp knife.

   When cutting out the bolt holes, obtain gasket punches from the tool room. These punches cut a nice, clean hole. Be sure to have the punch exactly on the spot where the bolt hole is to go through before striking with the hammer.

   Try the gasket in place and put the bolts through the holes to make sure everything fits. Be sure the dovetail fits correctly.

9. Push the flange back into place, install the bolts, and tighten securely.

apted from "Shipyard Outside Machinist", by State Department of Edu-tion, Alabama.

*Making and Installing a Grommet

INFORMATION

Grommets are used as gaskets to make a tight joint around b stud holes. They are made of lamp wick. When placed around a b stud and under a washer, they squeeze tightly into the space arou bolt when the nut is pulled tight. In making shell-of-the-ship or head joints, it is common practice to paint the grommet with whit or red lead putty. After hardening, the lead gives an additional ance of a sealed joint.

Where bolts are used, grommets (made as per sketch) are use on the threaded end. Grommets for the head end are made by wrappi proper length of wick around the bolt after washer has been pla bolt. The length of the wick is determined by the size of the s bolt, for example:

for 1/2" cut off 18" of wick
for 5/8" cut off 24" of wick
for 3/4" cut off 30" of wick

TOOLS AND EQUIPMENT

1. Rule
2. Pocket knife

MATERIAL

Ball lamp wick and stock grommets

PROCEDURE (If grommets are made on the job)

1. Cut off 18" length of wick.
2. Wrap wick around forefinger 2 to 4 times, depending on size of bolt. The remaining wick will be about 12" long.

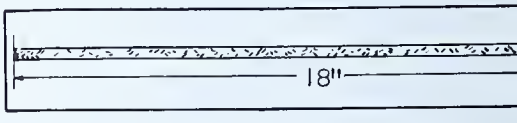


Fig. 134--Length of Lamp Wicki

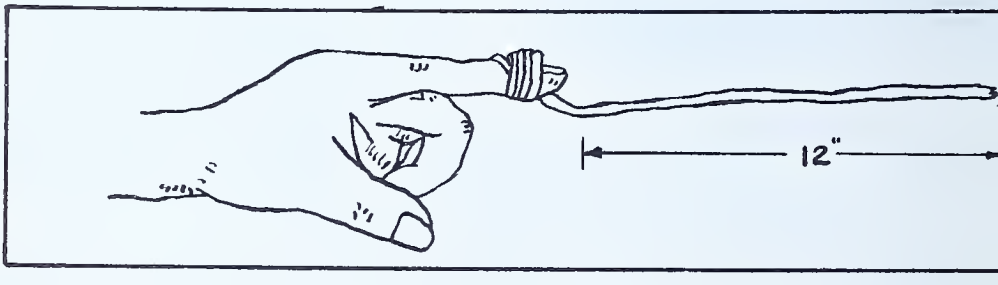


Fig. 135--Wrapping Wicking Around Finger

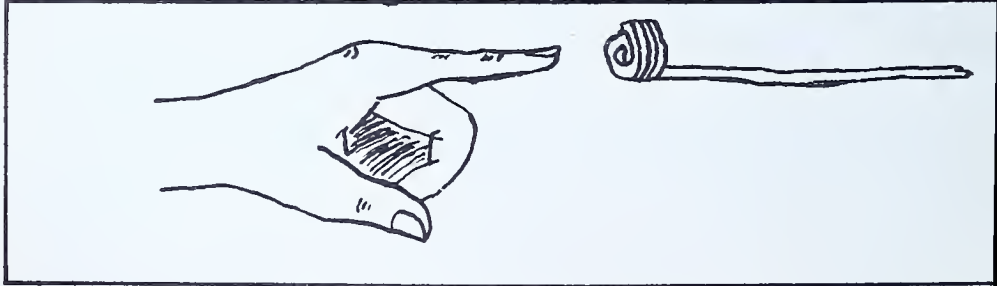


Fig. 136--Loops Removed From Finger

3. Slip the ring off the finger. See Fig. 136.
4. Pass end of wick through ring until the circumference of ring is completely covered. See Fig. 137.

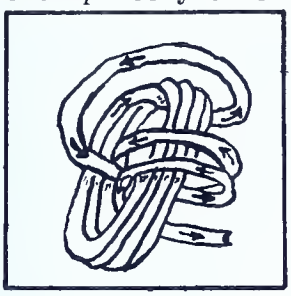


Fig. 137--Covering Loops

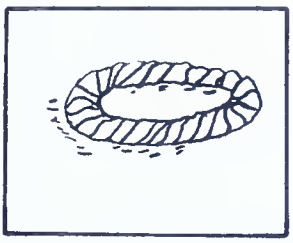


Fig. 138--Finished Grommet

5. Pull the wick tight so that the grommet will not be lumpy. See Fig. 138.

NOTE: In some shipyards a full line of grommets is carried in the storeroom. In this case it is unnecessary to make grommets by hand. Fill out a requisition, and after the leader approves it, present it at the storeroom.

QUESTIONS

1. For what purpose is a grommet used?
2. How is a grommet prepared to make sure it is leak-proof?
3. When are hand-made grommets required?
4. Is it possible to use a grommet the second time? Explain.
5. What happens if the grommet is lumpy and does not pull down evenly?

apted from "Shipyard Outside Machinist", by State Department of Edu-tion, Alabama.

Packing a Stuffing Box

ERAL INFORMATION

A stuffing box is necessary to prevent leakage of steam, oil, or er around such places as a steam valve shaft, a deck stand operat- stem, or a circulating pump shaft. In most cases packing must be ced after the unit is installed with the shaft in position. In er cases the packing is already in place, but must be checked to e sure there is no leakage.

ES OF PACKING USED

Many types of packing are used. One type of packing looks much the e as another type, and care must be exercised to make no mistake in ecting the correct type.

The usual practice is to use:

1. Flax packing on water cylinders.
2. Semi-metallic packing on valve rods and piston rods (steam)

3. Graphited, long-fiber asbestos on fuel oil pump piston ro

Always check with the leader to avoid errors.

Packing comes in long strips, usually in coils shaped like a spring. The packing m round or square in cros tion. The square pack used to better advanta most cases, because it co to the shape of the stuff more closely.

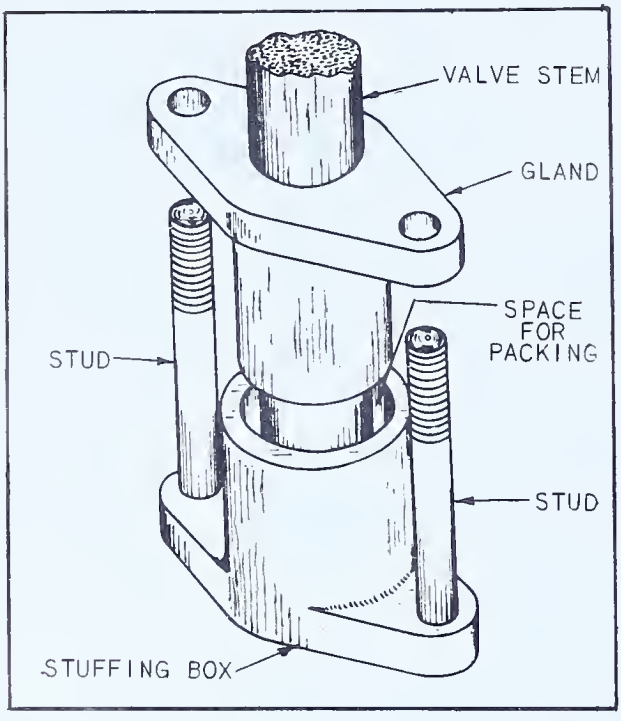


Fig. 139--Stuffing Box Assembly

Fig. 139 shows a t pump stuffing box and The gland is the piece t pressed into the stuffi by means of bolts and Pressure causes the pack squeeze tightly again shaft and prevent leakage

TOOLS AND EQUIPMENT

1. Open end wrench
2. Pocket knife
3. Packing hook

MATERIALS

Packing

GENERAL PROCEDURE

(a) When using single rings cut from coil

1. Measure distance between the wall of the stuffing outside of gland.

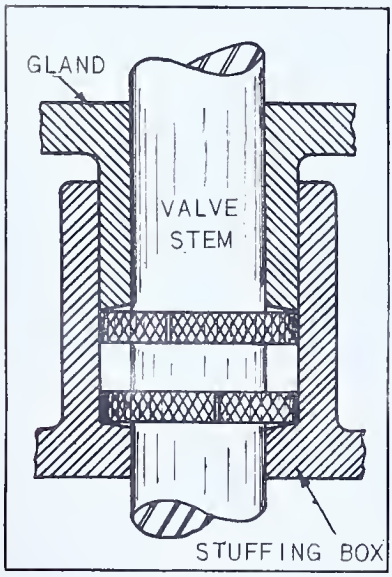


Fig. 141--Packing in Place

NOTE: When the mechanic is packing a box by this method, he should cut the packing slightly short, to prevent butting the ends and buckling them. See Fig. 140.

Each ring should be inserted and pushed as far into the box as possible with the gland. See Fig. 141.

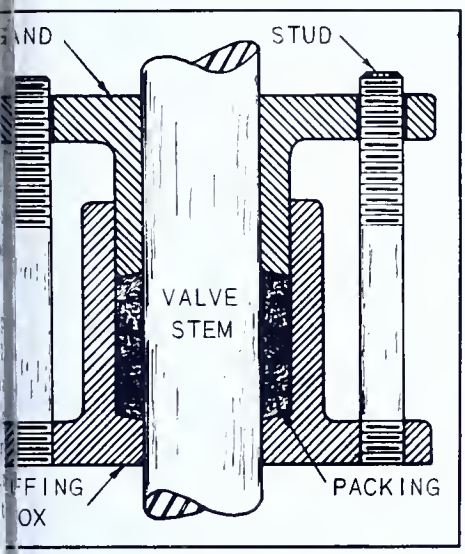
The split or joint of the following ring should be staggered, to prevent a blow-by channel. See Fig. 142.

When the box is full, press the packing rings down with the gland and start both nuts. See Fig. 143.

Fig. Single

Fig. Staggered

(b) When using packing cut in one piece from coil



143--*Cross Section of Packing*

1. Find the outside circumference of the box, and cut off one piece of packing long enough to fill the stuffing box completely.

Fig. 144--Pushing Packing Down

. Start one end of the strip of packing and carefully coil it around the stem of the valve or piston rod, using the packing hook (dual purpose), a wooden stick, or the gland, to press the packing into the space evenly.

. When the box is full, slide the gland down. See Fig. 144. Using a little pressure, start both nuts.

. Tighten each nut a little at a time, keeping the tension uniform to prevent cramping the gland on the stem, and so prevent misalignment and undue wear.

. Check with the leader for his approval.

NG BOX PACKING MAINTENANCE

Keep boxes well filled with a good quality packing. Screw the s down at first just enough to prevent leakage. When the packing ecome adjusted to the shaft under working conditions, the gland e tightened further to prevent leakage.

Repack the stuffing boxes before the packing becomes so hard that l score the rod.

NOTE: The correct amount of packing to use is best learned by experience. Check with the leader the first few times to make sure the job is being done correctly.

QUESTIONS

. Why is it important to put as much packing as possible into a newly packed stuffing box?

. What is the purpose of a stuffing box gland?

. State how the measurements of a stuffing box are taken to get the size and length of the packing strip.

4. What tools are used when packing a stuffing box?

5. Explain how the mechanic knows when the gland is pulled down tight enough.

*Making a Watertight Joint

INSTALLING A GASKET AND GROMMETS

When tanks are filled with liquid, pressure is exerted on all sides. If at any time a pipe connection is below the level of liquid, there is danger of leakage around bolts or studs. For this reason gaskets are used on each side of each stud hole. These gaskets are made of lamp wick and are known as grommets. See Fig. 145.

Washers are used to press them down watertight. In some cases, such as shell-of-ship joints, the grommets are painted with red lead putty.

In Fig. 145 a 3" vent is shown flanged to the top side of a small tank. It is taken for granted that holes have already been drilled and tapped, and that the studs are in place.

TOOLS AND EQUIPMENT

1. 5/8" end wrenches

MATERIALS

Eight 5/8" washers (cu)
Eight 5/8" hexagon nuts
Studs
One ball lamp wick, cu
8 - 5/8" grommets
One 3" full-face gasket

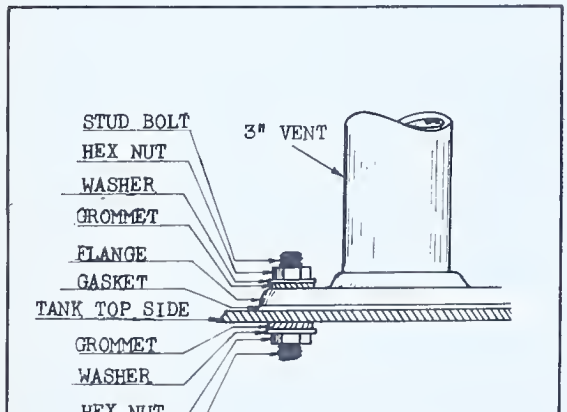


Fig. 145--Watertight Joint Assembly

GENERAL PROCEDURE

1. Make eight 5/8" grommets. See Fig. 145.
2. Take four grommets, four washers, four nuts, and 5/8" wrench, and go inside tank.
3. Put a grommet, then a washer, then a nut on each stud and pull nuts down tight. See Fig. 145.
4. Come outside tank, and place gasket and flange in position.
5. Place grommet, washer, and nut on each stud; and pull nuts down tight. See Fig. 145.

QUESTIONS

1. Why is a washer placed between the nut and the grommet?
2. What happens to the grommet when the nut is pulled down tight?
3. Why is a full-face gasket used between the flange and tank?

4. What is the reason for using "dope" on a grommet before placing the steel washer and pulling the nut down?
5. Would it be practical to make a watertight joint without the use of grommets?

lapted from "Shipyard Outside Machinist", by State Department of Edu-ıtion, Alabama.

Overhauling a Valve

'ORMATION

This job instruction sheet applies prin-)ally to globe and gate valves.

The many globe and gate valves of var-ıs sizes aboard ship must be overhauled)m time to time. The wearing and pitting globe valve discs and seats cause leaks. lve stems get bent, packing between the)nnet and the valve body must be renewed,)l and worn stuffing box packing must be re-)aced, and possibly a scored stem may have be removed and a new stem installed. See g. 146 for globe valve exterior.

Fig. 146--Globe Valve

The glove valve seats must be ground to iew fit after they have become worn. This not possible with gate valves, on account the wedge gate construction. If not rn too badly, the seat ring and the disc ring of a gate valve may be scraped slightly to a new fit; but such cases are usually rare. New seat rings and new disc rings are installed when a gate valve is badly worn. See Fig. 147 for gate valve exterior.

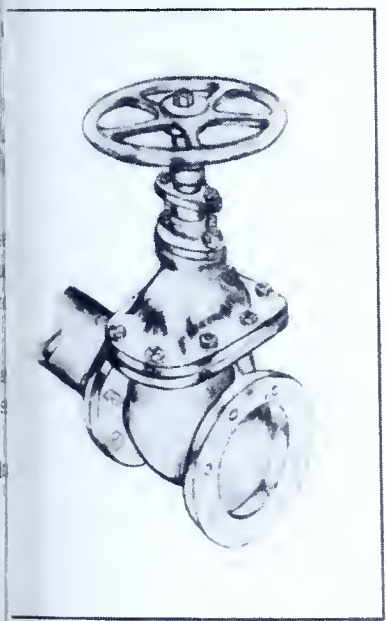


Fig. 147--Gate Valve

The work of dismantling and reassembling either type of valve is essentially the same. Where, because of size, the construction of valves differs, a slight change in the use of the tools and the handling of the valves will necessitate departures from the procedure as outlined below. The illustrations of the valves given in this instruction sheet are typical. The details may vary slightly according to the valve manufacturer's specifications.

)LS AND EQUIPMENT

Regular tools

MATERIALS

Globe or gate valve
Gasket material
Stem packing
Grinding compound

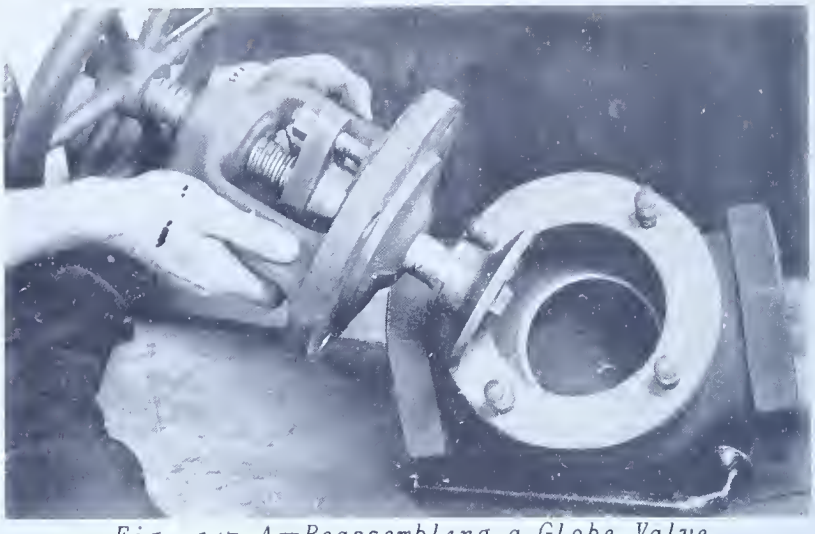


Fig. 147-A—Reassembling a Globe Valve

PROCEDURE

1. Secure the proper size of wrench, and remove nuts from bonet studs.
2. Mark bonnet and valve body for replacement identificati h. Remove bonnet by turning stem hand wheel in the direct on marked "closed" on the wheel until the bonnet flange ri es free of the valve body.
3. Lift bonnet, with stem and disc assembled, from the valve bcy. If the bonnet is "frozen" to the valve body, use fox-wedes to start the bonnet. The knife edges of the wedges must bein good shape. Start the wedges evenly, all around, until ne bonnet breaks loose. This step applies especially to lage valves.

   NOTE: After the bonnet assembly has been removed from he valve body, check the flange faces on the bonnet and on the body for misalignment, scores, and battered plaes. Use a surface plate, a straight edge, or some oter level surface as a guide in checking. A close inspc-tion will reveal whether or not it is necessary to snd the job to the machine shop for re-conditioning.
4. Remove nut or pin from the stem and remove the valve disc.
5. Test the valve seat by sounding with a small hammer or he head of a chisel. Use care not to scar the valve seat.
6. If the seat is found to be tight in the valve body and neiter the seat nor the disc is scarred too badly, replace the dsc in position on the valve seat to "grind in" with grindns compound. Grind valve as per instructions in *Grinding Vave Seats.* (Page 113.)
7. Examine the seat for a groove or shoulder. If the seati "grooved" or "shouldered", it will have to be refaced in h machine shop or with a valve-reseating machine. See Fis 148-A and 148-B.

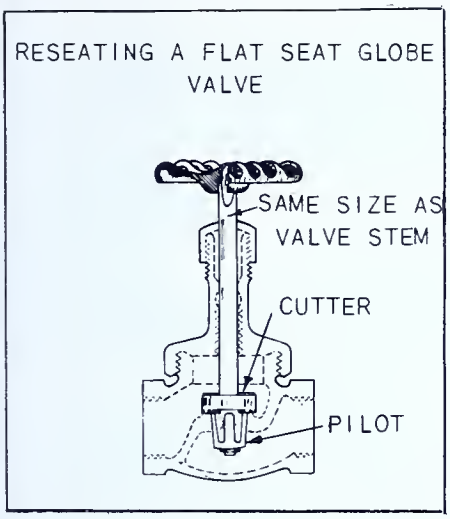


Fig. 148-A—A Flat Valve Seat Refacing Tool

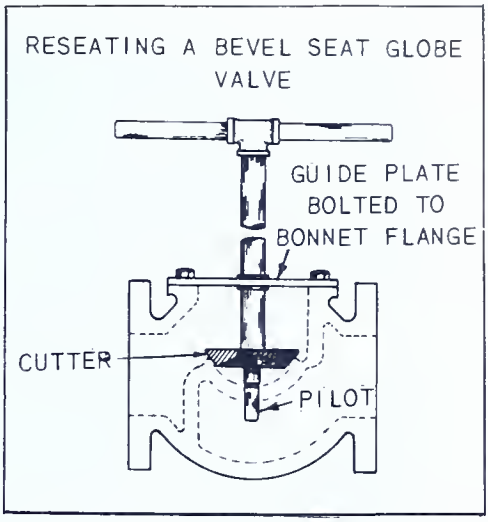


Fig. 148-B—Bevel Valve Seat Refacing Tool

NOTE: Look for poor fits caused by too deep a seating of the valve disc on the valve seat, too wide a contact between the valve disc and the valve seat, or a bent valve stem which allows the valve disc to seat on one side only.

8. Install the new valve seat at this point. Seat the disc by "grinding in". Check with the leader for his approval.
9. Remove the old packing from the valve stem gland and replace with new packing. Pull packing gland down tightly.
10. Examine valve stem bonnet studs and nuts for deterioration, bad threads, or fractures. Replace any that are found defective.
11. Make a new gasket for the bonnet, using the old gasket or bonnet flange for template.
12. After the valve disc is on the stem and secured in place with nut or pin, make sure that the disc will float on the stem to allow for proper seating. See Fig. 147-A.
13. Replace bonnet in original position. Be careful that the pilot of the disc enters the guide hole in the center of the seat.
14. Turn the valve stem wheel toward the "open" position until the disc leaves the seat and the flange of the bonnet comes in contact with the flange of the valve body.
15. Replace the nuts and tighten evenly by going around with the wrench several times.
16. Turn the valve stem wheel toward the "closed" position until the disc comes in contact with the valve seat.

Figure 149 shows a group of gate valves which are used in the iquid cargo lines. The mechanic usually brings his tools to the lo- ation of the overhaul job and performs his work there. This procedure liminates the possibility of losing valve parts which would likely appen if they were carried away from the job to be worked upon else- here.

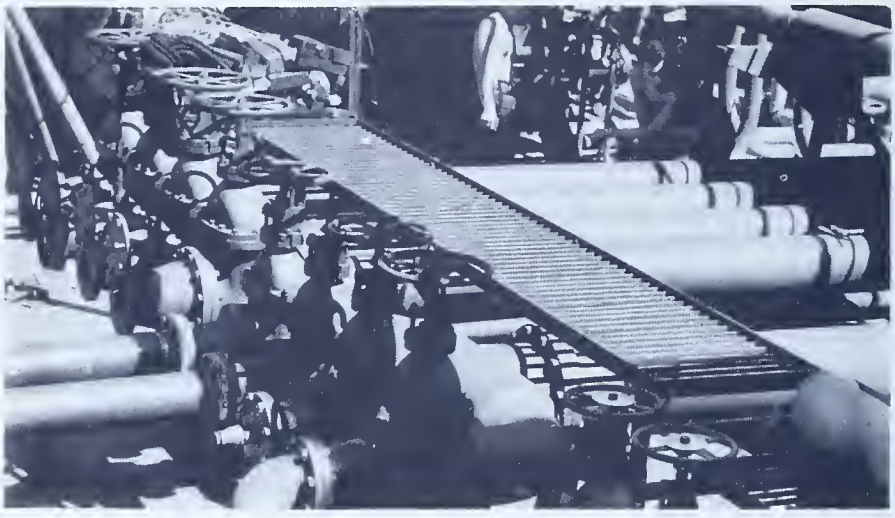


Fig. 149—A Group of Gate Valves on the Weather Deck

QUESTIONS

1. State some of the reasons for overhauling valves.
2. What is the correct procedure to follow when a globe valve seat and valve disc are badly scored?
3. When a gate valve leaks how may the valve seat ring and disc ring be brought to a correct fit?
4. Explain the principal difference between a globe valve and a gate valve.
5. What is the purpose of a valve bonnet?
6. Name the four important parts of a globe valve.
7. If a globe valve seat is scored, is there any way it may be refaced without removing it from the valve? Explain.
8. Point out the correct method of testing a valve seat to discover if the seat is solidly in place or if it must be replaced.
9. Explain what is done with the gasket and the packing when overhauling either a gate valve or a globe valve.
10. What is the chief purpose of the pilot on the bottom side of a bevel valve seat?
11. State the probable result if the valve bonnet is replaced in an opposite direction from the original position.
12. Where are fox wedges used when overhauling a valve?

Grinding Valve Seats

INFORMATION

A valve can be used for only a certain length of time before the working faces must be reconditioned. Grit, corrosion, and friction cause pitting and grooving. When this condition gets to a point where the valve leaks, it must be refaced by grinding.

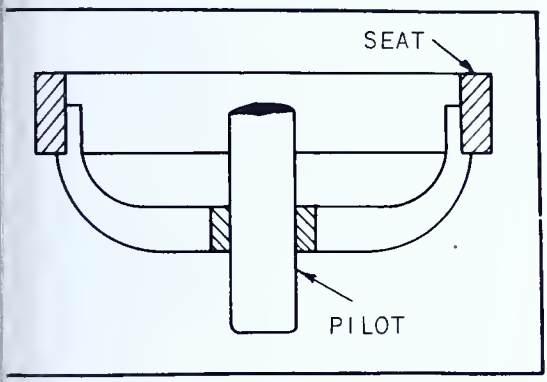


Fig. 150 — Pressed-in Valve Seat

This operation is very similar to grinding automobile valves. Some valve seats (see Fig. 150) are pressed into the body; and some (see Fig. 151) are screwed into the body. In either case, the valve seat may be removed if replacement is necessary.

When the valve seat screws out, a special tool is used to fit into the lugs provided for this purpose. When the valve seat is pressed into place, a special puller is used to remove the seat. Check with the instructor for the correct procedure.

Make every move count. Be sure of the correct thing to do before going ahead. A false move can ruin a valuable piece of equipment.

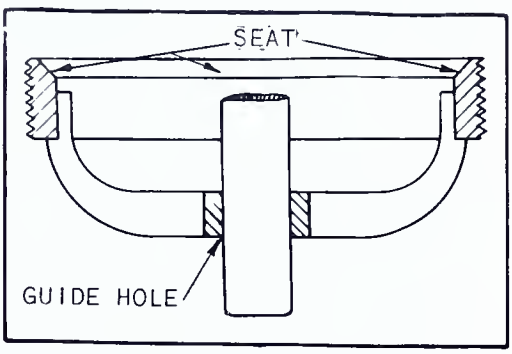


Fig. 151 — Screwed-in Valve Seat

TOOLS AND EQUIPMENT

Regular tools
(See leader)

MATERIALS

Used globe valve
Gasket material
Stem packing
Grinding compound

DISC END OF GLOBE VALVE

When the stem is turned down to close the valve, the valve "floats" on the end of the stem and allows the valve to "seat" evenly all the way around.

The lockwasher "a" is turned down on the disc on one side and turned up on the nut on the opposite side. See Fig. 153.

VALVE SEAT DISC

Figure 152 shows a typical globe valve cross section assembly. Globe valve sizes are the same as the size of the pipe to which they are bolted. For example: A 12" globe valve is used with a 12" pipe. For

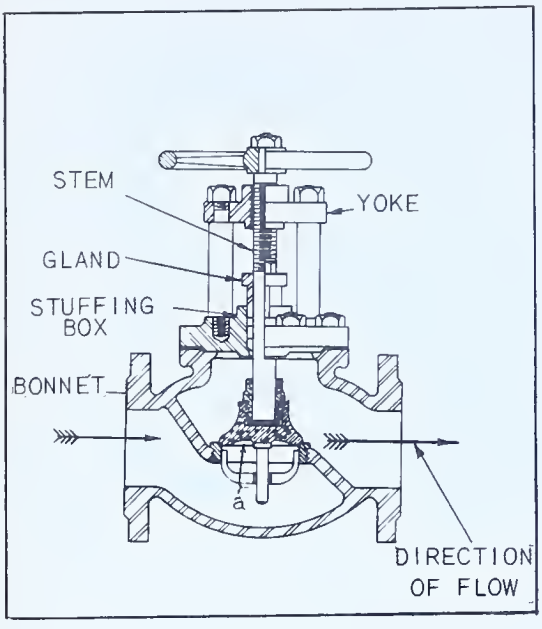


Fig. 152--Globe Valve Cross Section

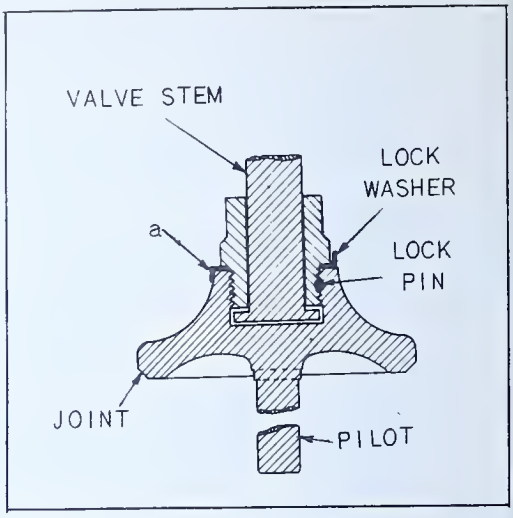


Fig. 153--Valve Seat Disc

diameters up to 12", measure the inside diameter of the pipe for the size. The inside diameter of a 12" pipe is 12.09 inches. The thickness of the wall of the pipe is .33 inches. See table of pipe sizes in the appendix.

The type of valve shown in Fig. 152 has a bonnet which is of flat plate construction type with a yoke assembly secured to the bonnet with studs. The bonnet is bolted to the valve body by means of these studs and well-fitted hexagon nuts. The action of the mechanism in opening and closing causes the valve disc to rise with the stem. A valve of this type is called a globe stop valve. The valve disc is fitted to the valve seat as follows:

(a) Apply grinding paste to the valve disc.
(b) Hold the valve disc firmly against the valve seat.
(c) With a circular motion, turn the disc back and forth on the seat until a perfect joint is made between disc and seat.

(See Procedure for complete details.)

Figure 154 illustrates a typical gate valve with a raised bonnet. The operating mechanism in a gate valve raises and lowers a wedge-shaped gate which regulates the flow of steam, water, or oil. The raised bonnet provides a space into which the gate may rise when the valve is opened. See Fig. 154-A. The bonnet must fit the valve body-flange perfectly. A gasket in the joint between flange and bonnet prevents leakage.

PROCEDURE (Applicable in most cases.)

1. Remove bonnet, valve stem, and valve disk as instructed in "Overhauling a Valve".

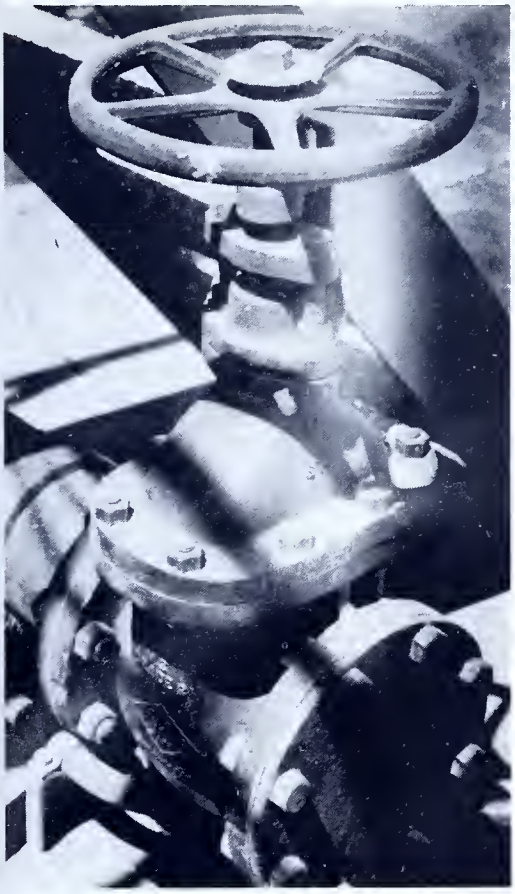


Fig. 154

Fig. 154—Gate Valve Installation

operation. Place the spring under the valve and allow the valve stem to drop through the inside diameter of the coils. Pressure will have to be applied to make the valve disc contact the valve seat.

Raise the valve disc after a few turns, and turn it to a new position on the seat. Continue "grinding" backwards and forwards as before.

Follow the procedure in Steps No. 5 and 6 until the valve disc has been turned one complete revolution. Some valves may need two complete revolutions to make the seat and disc fit perfectly.

2. Remove nut or pin from stem and remove the valve disc.

3. Test the valve seat by sounding with small hammer or the head of a cold chisel. Use care not to scar the seat.

4. If seat is found to be tight in the valve body and neither the seat nor disc is scarred too badly, replace disc in position on valve seat to "grind in" with grinding compound. Fasten the disc firmly to the stem by placing a thin washer or shim between the valve disc and the nut or fastening pin.

5. Seat disc to valve seat by smoothing grinding compound on the valve disc, press down firmly on seat, and "grind in" by turning valve stem backwards and forwards several times.

NOTE: Procure an "open coil" spring with sufficient tension to carry the weight of the valve stem assembly and to lift the valve from the seat during the grinding

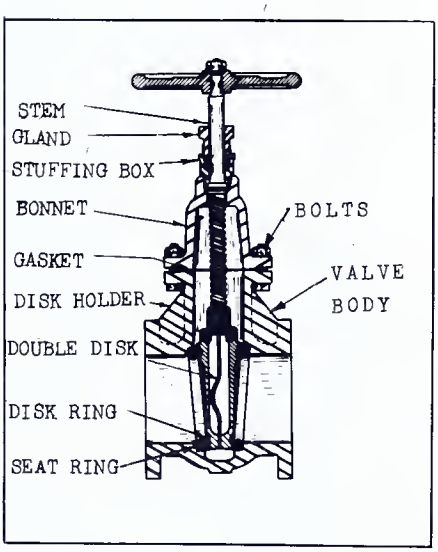


Fig. 154-A Gate Valve Cross Section

8. Remove the disc, and wipe the compound from both the seat and the disc. Examine for scars which may cause a leak.

   NOTE: The grinding compound must be completely removed from the valve seat and from the valve disc. Washing the surfaces with a liquid cleaner will insure a clean surface and eliminate the possibility of any of the compound adhering and causing a score.

9. Examine disc for groove or shoulder. If one is found, the disc will have to be refaced in the machine shop or with a valve reseating machine.

10. By marking the seat about every half-inch with a lead pencil test valve to see if it is properly seated. See Fig. 155.

11. Replace disc to position on seat, press down firmly, and turn valve disc just enough to cut one line, that is, turn the valve disc only as far as the distance from one pencil line to another.

    NOTE: If marks are rubbed out all around, the valve disc is properly seated. Sometimes the same procedure is followed and prussian blue is used instead of pencil marks. Blue either the valve disc or the valve seat. Blue either one, but not both.

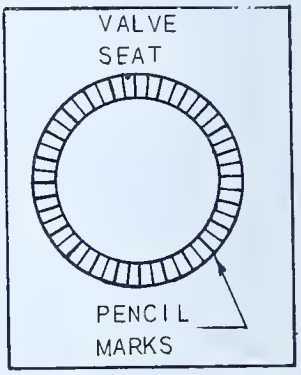


Fig. 155—Checking the Seat

12. Replace the valve disc on the stem and secure in place with the nut or pin. Make sure that disc will float on stem to allow for proper seating.

13. Check with the leader or inspector for his approval.

14. When the work is approved by the leader, proceed to re-assemble the valve.

QUESTIONS

1. How is it determined whether or not the valve seat is tight in the valve body?
2. If the valve seat is not tight, what is the correct procedure?
3. Explain how valve seats are taken out of a valve body.
4. State the reason for removing the valve seat from the valve body.
5. If the valve disc is badly scored, what is the correct procedure?
6. Why is it necessary to have a very narrow point of contact between the valve disc and the valve seat?

7. Explain what happens when a valve disc pilot is a poor fit in the valve seat guide.
8. State the correct method of checking the accuracy of the fit between the valve disc and the valve seat.
9. When may a valve-reseating machine be used to good advantage?
10. Explain how valve-grinding paste, or compound, should be applied and removed during the valve-grinding operation.

Setting a Valve

WHAT "SETTING A VALVE" MEANS

When the machinist is installing valves of various types, he must give some attention to the position of the valve stem; the direction in which the steam, water, or oil flows; the the tension that he gives to the bolts that hold the valve flanges to the adjoining pipe flanges or other unit. The phrase "setting a valve" has nothing to do with the opening or closing of the valve. When a valve is only slightly opened it is said to be "cracked".

VALVE FLOW (Globe valve)

Figure 152 shows the direction of flow (arrows) through a globe valve. Note the pressure of the flow is up and against the valve disc "a". As the valve stem is opened up, the pressure of the flow is against the valve disc. Always examine the valve carefully before setting it, to see which direction the flow is marked on the valve.

If the direction of flow is not marked, examine the inside of the valve to see which end the flow enters to *lift* the valve disc. Then, make sure of the direction of the flow through the pipe, or opening, to which the valve is to be attached. When all the above has been determined, match the direction of flow through the pipe with the direction of flow through the valve and bolt up.

VALVE FLOW (Gate valve)

Gate valves may be set either way because the direction of flow may be either way. The only point to watch here is to see that the holes in the valve flanges match the holes in the pipe flanges to which the valve is to be bolted.

POSITION OF STEM AND HANDWHEEL

Valve stems are usually set vertically with the water line of the ship. See Fig. 156 at "v". Other valves may be set at an angle with the water line of the ship. See Fig. 156 at "w". Check the blueprint carefully to make sure this setting is correct. Straight and angle valves are always set according to the blueprint.

INSTALLING BOLTS

When the flange-to-flange joint is metal to metal, the bolts may be drawn up as tightly as the bolt thread and nut will stand.

When a gasket is used between joints, the bolts can be drawn up too tightly. Give every nut a little strain to draw the flanges up

evenly, and go over all the nuts several times until the gasket is firm ly held, but not squeezed out at any point. A joint can be made t leak if this part of the work is not watched very carefully. Chec with the leader for the proper bolt and nut tension.

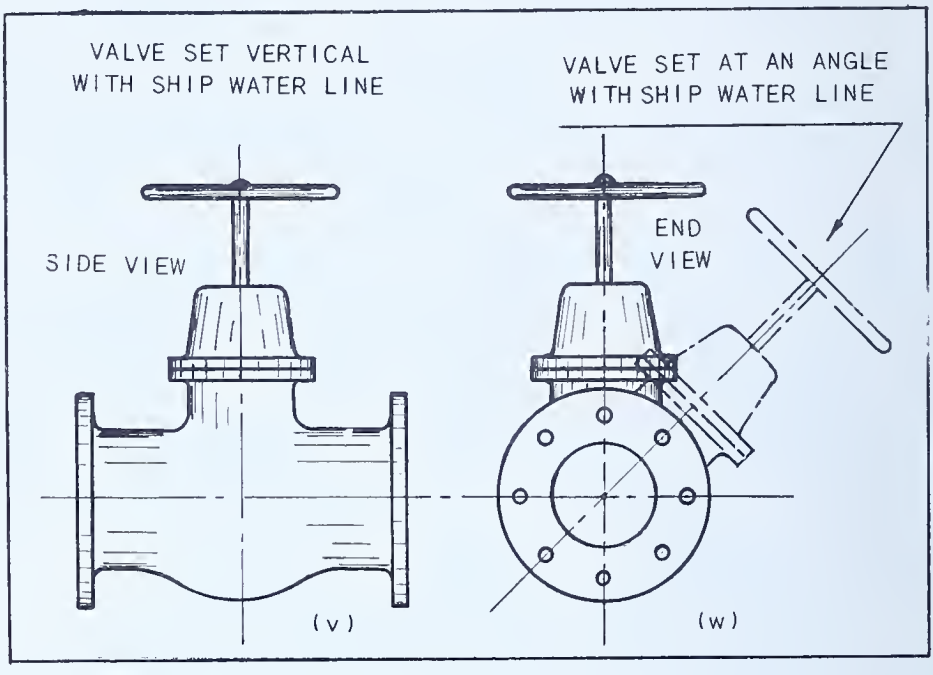


Fig. 156—Two Ways to Set a Valve

The work sequence for setting valves is as follows:

PROCEDURE

1. Select the correct type and size of valve according to te blueprint.
2. Examine the valve for direction of flow.
3. Check with blueprint to determine angle for setting the vale stem.
4. Check connecting point for direction of flow.

   NOTE: Overboard discharge valves flow outboard.
   Suction valves flow inboard.

5. Place the valve and insert the bolts.
6. Draw the bolts up tightly as instructed.
7. Check with the leader for his approval.

QUESTIONS

1. Explain the direction of flow in a globe valve in relation to the valve disc.
2. How is the correct setting of a valve determined in relation to the flow?
3. What is meant by 'the tension on the bolts?

4. State the probable cause for gasket-joint leaks when the machinist tightens the bolts.
5. Explain what is meant by setting the valve stem at the correct angle.
6. Where is the correct valve-stem angle obtained?
7. What is the difference between a straight globe valve and an angle globe valve?
8. Compare the direction of flow in a globe valve with the direction of flow in a gate valve in regard to the setting of the two valves correctly.

Using a Declivity Board and Level

JRPOSE OF A DECLIVITY BOARD

In order to make launching a ship possible, the ship is built on ı incline with the bow higher ıan the stern. When the ship ; ready for launching, it ides down this prepared in- ine.

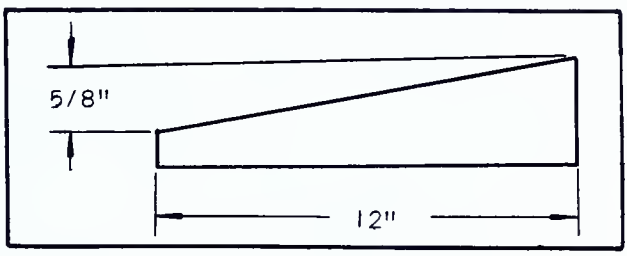


Fig. 157—5/8" Declivity Board

A declivity board is ed during the erection of ıe ship when on the ways. ıis means that throughout e construction of the ship lowance must be made for this slant in the ways. The declivity ard is the instrument that is used to compensate for this slant and ke possible the use of a level. See Fig. 157.

The declivity board is tapered exactly the same amount as the ant of the ship while on the ways. It follows that all units which e installed on board ship must be placed in such a position that ıen the ship is launched, the units will ride level with the ship. ıe declivity is usually marked on the ways. Declivity boards are de in the carpenter shop and have a taper corresponding to the de- ivity marked on the ways. This is usually 5/8" per foot. Thus a clivity board one foot long is 5/8" wider at one end: The narrow d is 4" and the wide end is 4-5/8". Fig. 158 shows how a declivity ard is used to level an installation.

Take a good look at the illustrations on the next page. Fig. 158, "a" is what a person would see if he stood with his face toward the b as shown by the figure of the little man. His left side is toward e bow of the ship; his right side is toward the stern of the ship; and is facing toward the starboard side of the ship.

He is standing on a tank top that makes a floor, level with the el of the ship. On his left is another tank top which rises a little gher than his shoulders. Above his head and in front of him is a ame work which has been welded in position to hold a bilge pump. This ame work is called a foundation. The foundation has to be level with e keel of the ship as it rides in the water. When the ship is on the

ways, the bow is much higher than the stern, 5/8" for every foot
length. If the ship is 500 feet long, the bow will be 26.04 feet high
than the stern.

Figure 158 at "b" shows a declivity board resting on the top of t
foundation and a level resting on the edge of the declivity board.
the declivity board is the same angle as the angle of the ship's ke
when on the ways, the top of the foundation will be level when the sh
is launched.

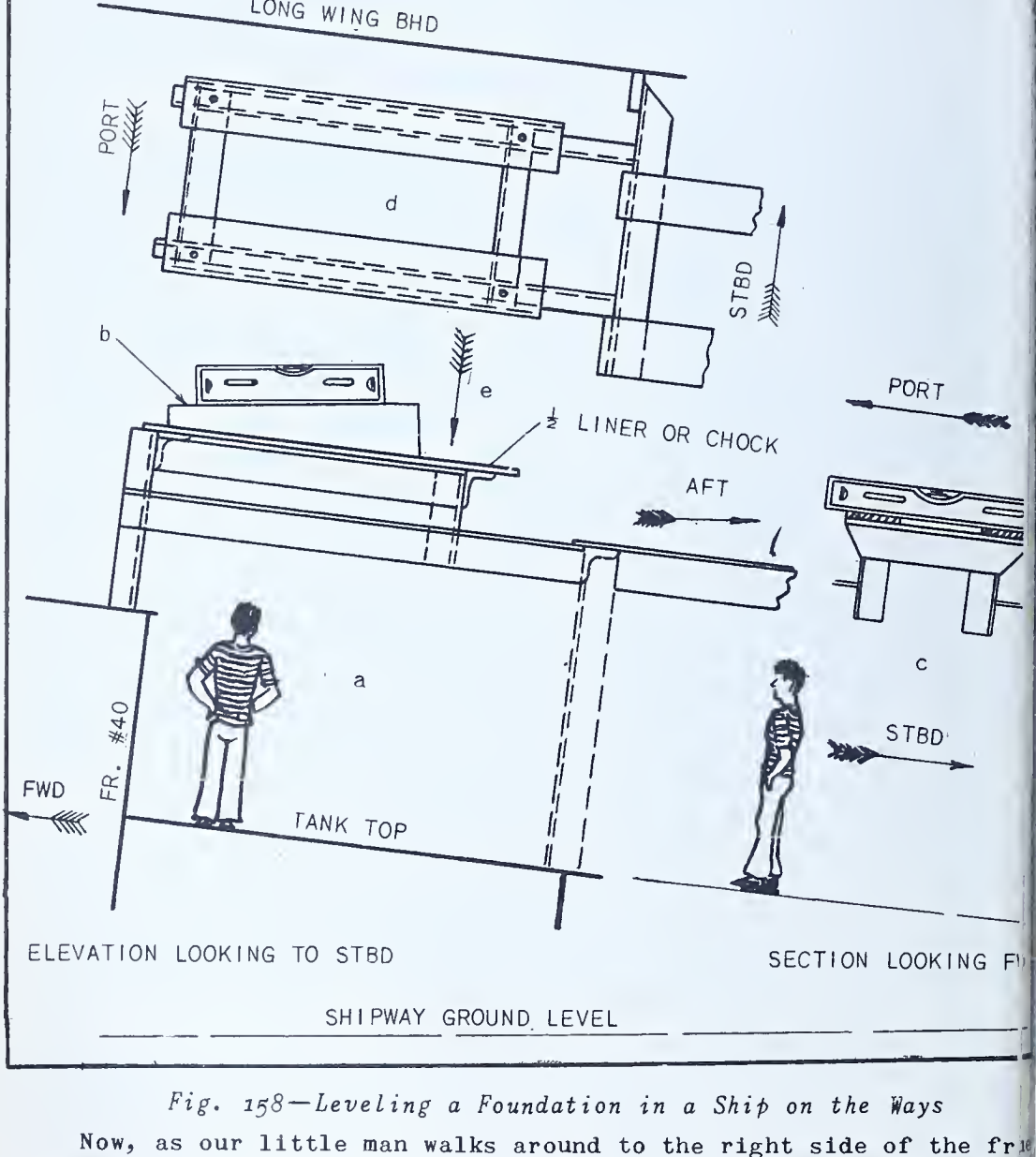


Fig. 158—Leveling a Foundation in a Ship on the Ways

Now, as our little man walks around to the right side of the fr
work and stands in the position shown he will see the platform top
shown in Fig. 158 at "c". As the platform in this view reaches i
port to starboard direction, and as the ship is resting level from p

to starboard on the ways, no declivity board is needed to make the foundation level athwartship.

Figure 158 at "d" is the top of the platform or foundation, and this is what the little man would see if he were standing right above the foundation and looking down in the direction of the arrow, 158 at "e".

Foundations are usually leveled up by grinding any high spots after the frame work has been welded in place correctly. But if some very particular job of installing a unit has to be done, the pump, or generator, or whatever it is, may be set up and leveled by following the outline given below.

GENERAL PROCEDURE

1. Locate the unit to be installed. See the blueprint.
2. Select a machined surface that may be used as a base on which to rest the declivity board. Check with the leader when choosing this surface.
3. Place small wedges or jacks for small units; use large wedges or special jacks for heavy units.
4. The declivity board is placed with the wide end aft when trying the work for level. See the illustration below.

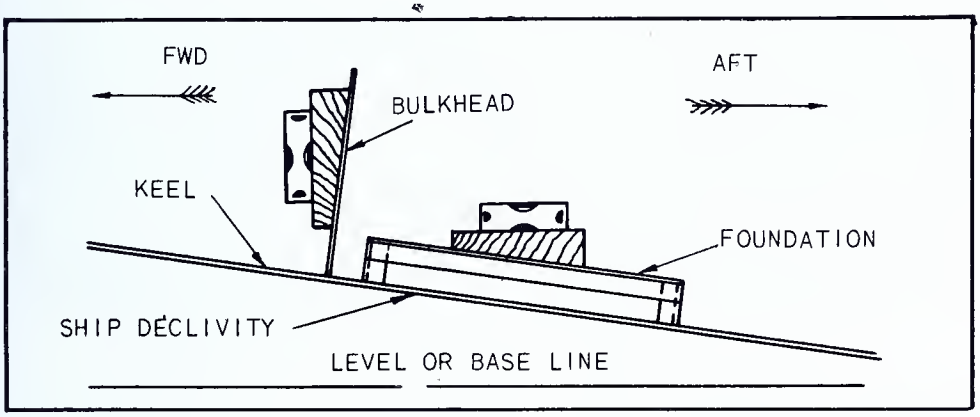


Fig. 159—Plumbing a Bulkhead in a Ship on the Ways

NOTE: When the machinist is plumbing bulkheads or other jobs involving the upright use of the declivity board, he must place the wide end of the board *up* and *forward* if he is trying the work for plumb on the *forward* side; he must place the wide end *down* and *aft* if he is trying the work for plumb on the *after* side.

5. Try the work with the level. Use wedges, or adjust the jacks to change the position of the unit being installed until the job checks level and plumb all around. Check with the instructor.

NOTE: When making the work level from port to starboard no declivity board is used. Use the level in the usual manner, but see that it is lined up on a true surface such as a tank top, the top of the foundation, or a generator flat.

QUESTIONS

1. What is meant by the "declivity" of a ship?
2. Explain the shape of a declivity board.
3. Where are declivity boards obtained?
4. How does one know the declivity of a certain shipway?
5. Why is a declivity board unnecessary when a unit is leveled athwartship?
6. Which end of the declivity board is up when the after side of a bulkhead is being plumbed while the ship is resting on the ways.

Striking a Chalk Line

PURPOSE OF A CHALK LINE

When locating a deck stand, a deck winch, or other similar uni the location must be found from the CENTER LINE on the blueprint. T center line of the ship should be marked with a center punch in the de plating. See line "1-1", Fig. 160. The center line of the unit loc tion must be marked parallel to the ship center line. See line "b-b Fig. 160. A chalked line is held through these two points parallel the ship center line, drawn taut, and snapped down on the deck. A fi chalk mark, parallel with the ship center line, will register on t deck. This chalk line is then marked about every two inches with center punch. See Fig. 160, "1-1".

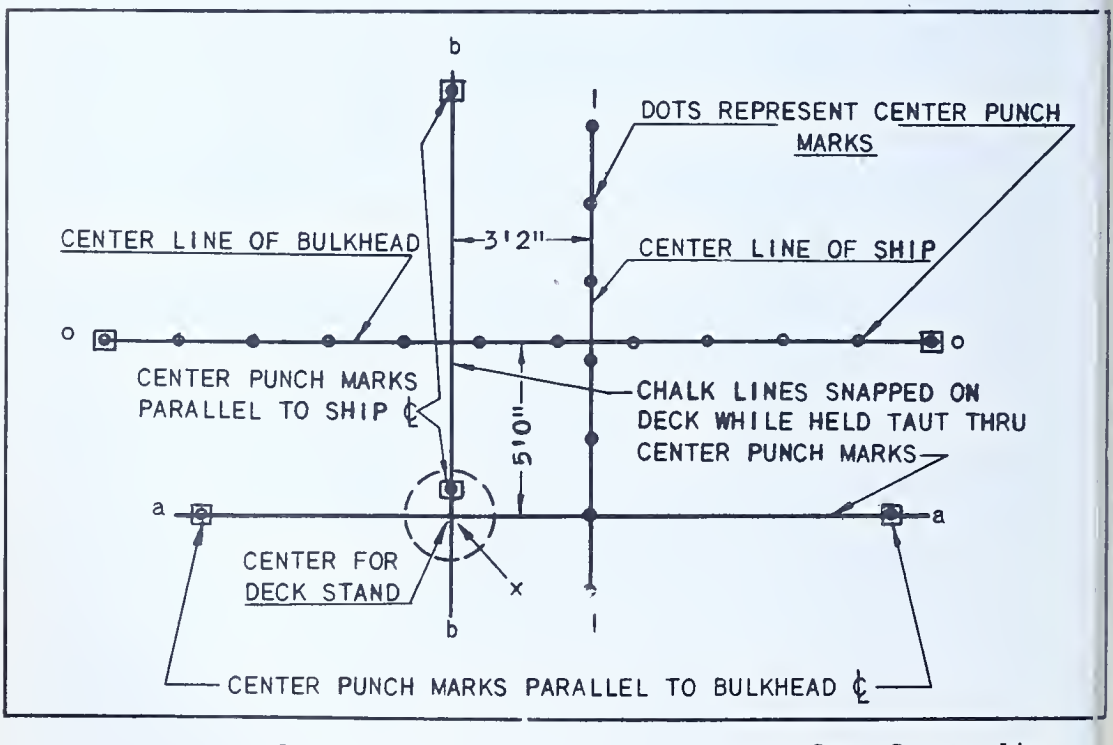


Fig. 160—Locating a Deck Stand Center from Ship Center Lines

The center punch marks in the small squares shown on Fig. 160 are ocated by measuring from the ship center line or from the bulkhead cen- er line. The ship center line and the bulkhead center line are usually enter punch marked on the deck of the ship. In some instances this is orgotten, and there is no center line from which to measure. When these enter lines have not been marked, they will have to be established at ace. *All measurements must be taken from center lines.*

To establish a center line when there is none marked, proceed as ollows:

1. Examine the blueprint carefully, and find the dimension which gives the distance from port to starboard from inside to inside of the sheer strakes.
2. Using one half this distance, measure from the port or starboard side, inside the sheer strake, from a point forward, inboard. See Fig. 161 at "r". Take another measurement from point "s" inboard. Mark the distance with soapstone at "t".

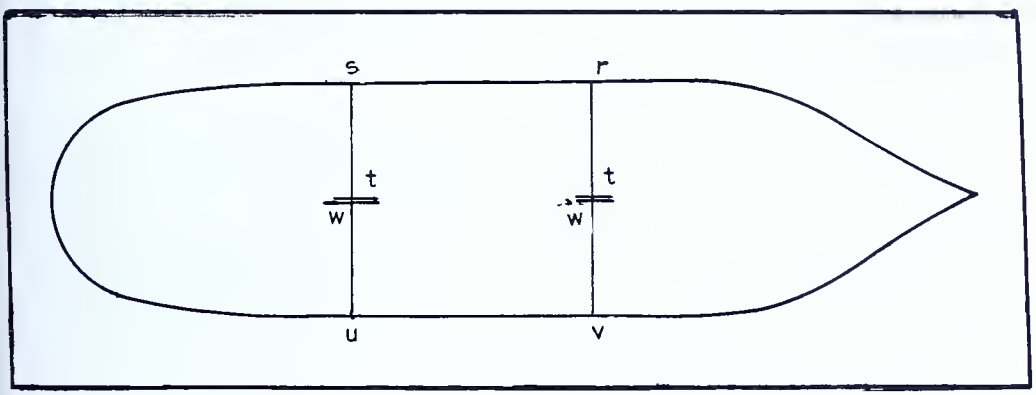


Fig. 161--Establishing a Center Line

3. Repeat step 2 from the opposite side at points "u-v" and mark the distance as before at points "w-w".
4. With the center punch, make a punch mark:
   (a) On the short lines if they come exactly in the same place.
   (b) Between the short lines if they do not come exactly in the same place.
5. With a cold chisel, make a square around the center punch marks as on the "1-1" line, Fig. 160.
6. Examine the blueprint carefully, and select a welded joint between two deck plates parallel to the bulkhead that comes close to the desired bulkhead center line.
7. Go below, and locate the distance from the weld to the bulkhead. Take this measurement at port and starboard.
8. Come up on deck, and lay this distance off from the welded joint in the desired direction.

9. Mark these points with soapstone, and center punch the locatio as in step 4. Box the center punch marks with cold chisel a in step 5.
10. With the chalk line held taut through the center punch marks snap a line on the deck plate, as at "o-o", Fig. 160.
11. Make center punch marks all along both center lines as shown o Fig. 160.

NOTE: When measuring distances, always measure at a righ angle from the starting point. Fig. 11 and 13, Part I.

LAYING OFF LOCATIONS

Having established ship and bulkhead center lines (or in case th center lines were already marked off on the deck), lay off the location or locations of units, as outlined below.

TOOLS AND EQUIPMENT

1. Center punch
2. Machinists' hammer
3. 6' steel tape
4. Chalk line

MATERIALS

Chalk
Soapstone
Cold chisel

PROCEDURE

1. Find the center line of the ship on the deck, "1-1", Fig. 160
2. Find the center line of the bulkhead, "o-o".
3. Measure off a distance of 5'-0" at a right angle from "o-(to "a-a" and mark with center punch as shown. Have cente punch marks as far apart as possible for greater accuracy.
4. With the chalk line held taut through the center punch mark "snap" the line on deck, leaving a chalk line.
5. Measure off a distance of 3'-2" at a right angle from "1- to "b-b" and mark with center punch as in step No. 3.
6. With the chalk line held taut as before, snap a line throu these center punch marks.
7. At "x", where the two lines "a-a" and "b-b" cross, is the cent of the deck stand location as shown by the broken circle.

NOTE: There may be several deck stands centered on the sa center line, about two feet apart. In this case, o center line will serve in one direction. Intersecti or cross lines for centers are measured off at rig angles from the main center lines "1-1" or "o-o".

Be sure to center punch the location of a chal line as soon as it is made. Unless this is done, t line may be blurred by footsteps or by objects dragg across it.

QUESTIONS

1. State the reason for holding a chalk line taut when striking a line.

2. What should be done immediately after a chalk line is struck on a surface?
3. Explain how the location of a chalk line is marked on a surface.
4. Point out the advantage of having center punch marks as far apart as possible when preparing to strike a chalk line.
5. At what point is the center of a circle found when chalk lines are used?
6. Explain how the center line of a bulkhead is located if it has not been marked with the center punch on the deck.
7. Why does the mechanic mark a box with a cold chisel around center punch marks?
8. When the distance athwartship measures 69'-11", what distance is measured to the center to find the ship center line?
9. If this distance varies slightly, fore and aft, how will the job of finding the ship center line be affected?

Setting and Fitting a Deck Stand

RPOSE OF A DECK STAND

Deep in tne hull of a tanker, valves are installed which control e flow of the cargo from tank to tank or from tank to discharge out- t. There may be valves, too, to control steam outlets.

These valves are operated from e weather deck. The blueprint owing the general arrangement of e weather deck will show the loca- ons for the upper end of the oper- ng rods which control the valves low decks. These operating rods e usually 1-1/4 inch diameter afting, hang from a support on the ather deck, and extend down to the lves. See "Installing Operating ls" for the arrangement or the lo- ion of operating rods.

The support on the weather deck r the upper end of the operating l is known as a "deck stand". See g. 162.

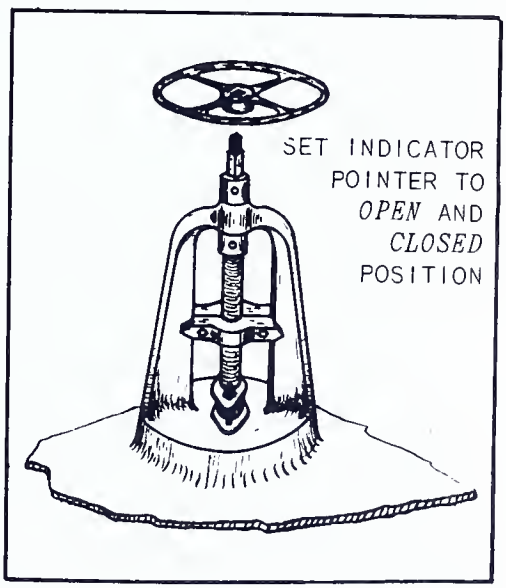


Fig. 162—Deck Stand Assembly

NERAL INFORMATION

Deck stands may be located on e weather deck, fore, aft, port, and starboard. While the deck pears to be level, it really is a curve, composed of straight lines. e Figs. 163, 164, 165. (Camber, sheer curve, camber curve.)

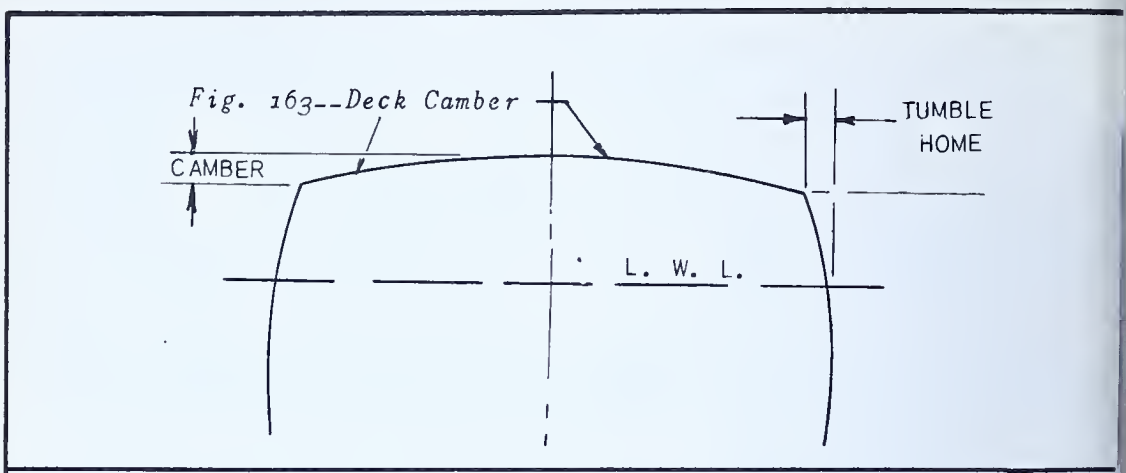


Fig. 163--Deck Camber

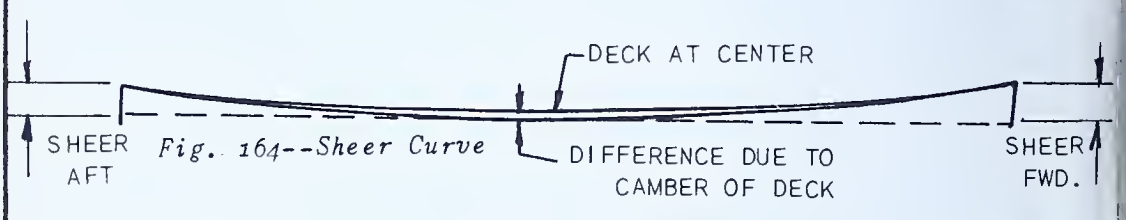


Fig. 164--Sheer Curve

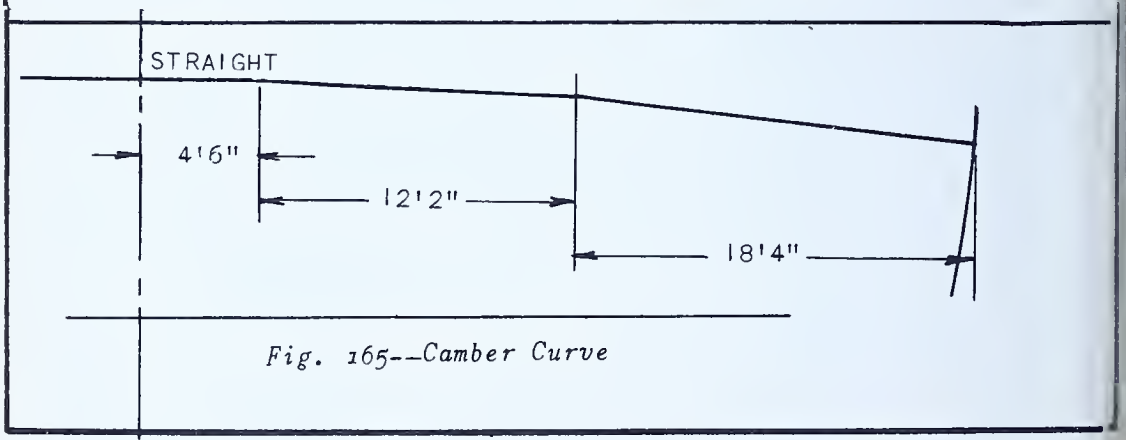


Fig. 165--Camber Curve

Curves That Must be Considered When Setting Deck Stands

A glance at the illustration of a deck stand will show that th base or bottom of the stand is straight and at right angles with the cen ter line. Each stand must be leveled with the vertical center line o the ship and machined off to fit the deck at the desired location

Figure 167 shows two deck stands installed on the weather deck o a ship. The deck stand at the left has been installed correctly, th is, vertical, athwartship. The center line of the deck stand, and o course the operating rod, will be parallel with the vertical center li of the ship.

The deck stand at the right shows what would happen if the stan had been set with the weather deck.

The operating rod would be cramped, especially if this rod is o hang straight down with no universal joints required. There would al

e a lot of trouble caused when the support brackets were being in-talled.

Deck stands must be fitted and set level.

The Hand-Operated Wheel Has a Square Hole Which Fits Over the Square End of the Operating Stem, A Nut is Placed on the Threaded Part of the Squared End and Drawn Down Tightly to Hold the Hand Wheel Securely in Place.

ig. 166—Deck Stand Installed

OOLS AND EQUIPMENT

1. Portable air drill
2. Chalk line
3. Fifty-foot steel tape
4. Center punch
5. Machinists' hammer
6. 10" dividers
7. Open end or adjustable wrench - 1/4" to 1" U. S. S.
8. Level
9. Declivity board

ATERIALS

Marking paint
Soapstone pencil
Blue or white chalk

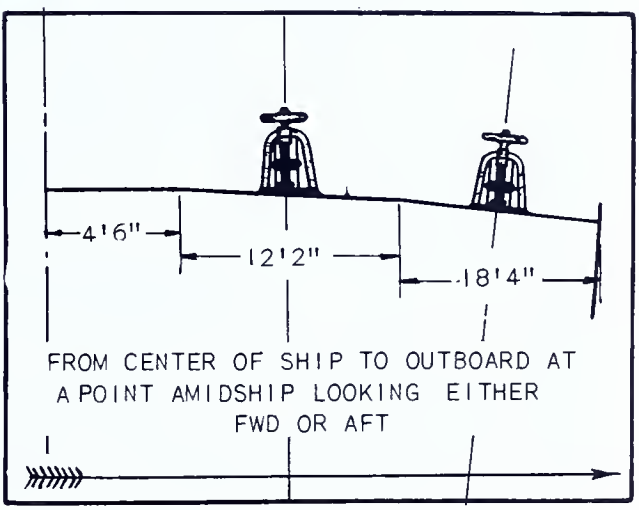


Fig. 167—Correct and Incorrect Deck Stand Setting

ENERAL PROCEDURE

1. Lay out location for deck stand from blueprint.
2. Place deck stand, and line up with level. (Use Declivity Board.)
3. Lay off base line on bottom of stand, level with ship declivity.
4. Mark location of deck stand on the deck with marking paint.
5. Take deck stand to machine shop and have it machined to base line.
6. Set it on a previously prepared location and have welded fast.

7. Install the indicator slide and pack the stuffing box after the operating rods are installed and inspected.

QUESTIONS

1. Explain the purpose of a deck stand.
2. State how the bottom of a deck stand is correctly prepared to insure that the vertical center line of the stern will be parallel with the vertical center line of the ship.
3. How is the deck stand fastened to the weather deck of the ship?
4. Why are deck stands located and installed before operating rods are fitted?
5. Why are brass sterns used in deck stands?
6. Give the reason for using a stuffing box on a deck stand.

Installing a Pump

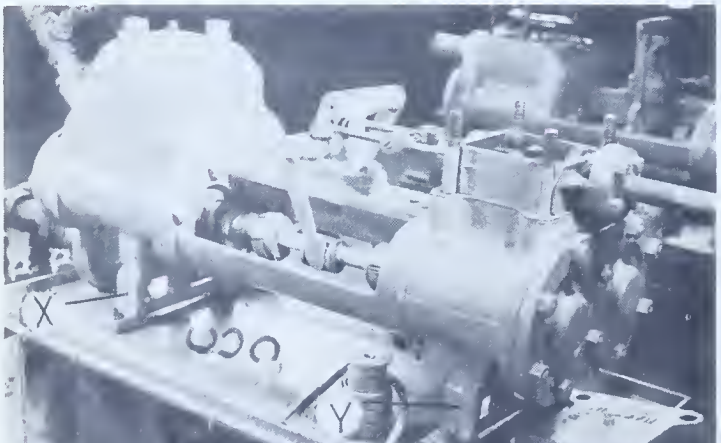


Fig. 168--Horizontal Steam Pump on the Foundation

Figure 168 shows a horizontal, duplex steam pump. The rigid base of the pump-body casting is supported on the foundation by two feet, "X" and "Y". The unit is lowered to place by the shipriggers under the supervision of the outside machinists. The blueprint gives the correct location for the pump and the number of bolts required to secure the unit to the foundation. The thickness of the chocks is determined by the distance between the foundation top and the underside of the supports "X" and "Y", which is usually one inch.

The instructions given herewith are understood to be general procedure. Larger units and different types of pumps may require the employment of installation methods not mentioned here. Circumstances will govern the procedure.

TOOLS AND EQUIPMENT

1. Center punch
2. Scale
3. Hammer
4. Dividers
5. Chalk line
6. Drilling machine
7. Drills
8. Reamer
9. Files
10. Chock sheets
11. Air grinder
12. Straight edge
13. Inside calipers
14. Outside calipers

TERIALS

Chalk
Chocks
Bolts

The work of installing a pump may be outlined as noted below:

ROCEDURE

1. Check the foundation with a straight edge to make sure it is level.
2. Grind off any high spots where chocks are to be fitted.
3. Place the pump in correct location given on the blueprint.
4. Place wedges under the foot support in a way which will not interfere with measuring between the foot and the foundation for chock sizes; and raise the pump to the correct height, which is shown on the blueprint.
5. Use inside calipers, and adjust the pump to the height shown on the blueprint.
6. Get chock sheets and write down the sizes for the chocks all around. Mark the chocks and the pump base for the chock locations.
7. Send the chocks to the machine shop to have them machined to the correct size.
8. Fit the chocks at the correct locations as instructed in Part II, Fig. 127.
9. Have the leader check the chocks.
10. If approved by the leader, drill the corner holes according to instructions.

    NOTE: The hole in the base may be used as a guide to drill the foundation. Sometimes the chock is drilled with the foundation; and at other times the position of the hole in the chock is scribed through the hole in the foundation, and it is centered and drilled in the shop. Circumstances govern the procedure.

11. Drill through the unit base, the chock, and the foundation with a drill of a size that will leave 1/16" in the diameter of the hole for reaming.
12. Ream to the size given on the blueprint.
13. Call for four fitted bolts from the machine shop, metal to metal fit. Give the diameter of the reamed hole.
14. Install the fitted bolts, and pull them down tight.
15. Drill the other holes in the base of the pump through the chock and foundation according to the size given on the blueprint.
16. Install black bolts in these holes, and pull them down tight.
17. Have the leader inspect the job and give his approval.

QUESTIONS

1. Why are the high spots ground off of the foundation where the chock is to be fitted?
2. Where do we find the location of the pump on the foundation?
3. Explain how wedges should be placed under the feet of the unit to prevent interference with measuring for chock thickness.
4. What is meant by a "metal to metal fit" when referring to fitted bolts?
5. How much is allowed for reaming in the drilled diameter of a hole?
6. Explain the procedure for drilling chocks.
7. State how the size of fitted bolts should be given to the shop when the size of the reamed hole is 1-1/2 inches.

Lining Up Pumps and Motors

IMPORTANCE OF ALIGNMENT

Pumps, motors, turbine generators, reduction gears, and excito are all found in different combinations aboard ship. These units a very costly, and a little carelessness in alignment may ruin bearings shafting because one unit of the group is not "in line" with anoth unit of the same group. See Fig. 169.

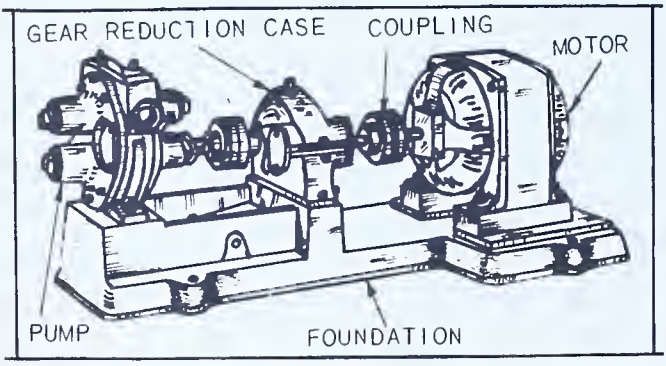


Fig. 169--Reduction Gear Driven Pump Setting

The illustration sho the motor set on a part of t foundation which is lower th the level on which the redu tion gear and pump are l cated. Instead of the foun tion shown, a welded ste foundation is often use The welded steel foundation not always absolutely leve although it may be fair flat.

After the foundation ground off as nearly perf as possible, there is still a chance that it may be slightly uneve This is the reason that chocks have to be used to level up the units, bring the center of the driving shafts in line so that they will t freely in the bearings. A tight bearing causes friction and quic overheats, resulting in a "seized" shaft or a "burnt out" bearing. rious trouble at a critical moment can result from faulty alignment units.

Figure 170 shows the coupled shaft which is used in the pump motor unit shown in Fig. 169. Points "a" and "b" must be in a horiz tal plane which is parallel to the horizontal plane of the unit foun tion.

The shaft "c", which is coupled between the two outer shafts, must ne up with the center line of these shafts so that the continuous cen- r line will assume a position exactly the same as if there were but e piece of shafting extending from end to end of the entire unit.

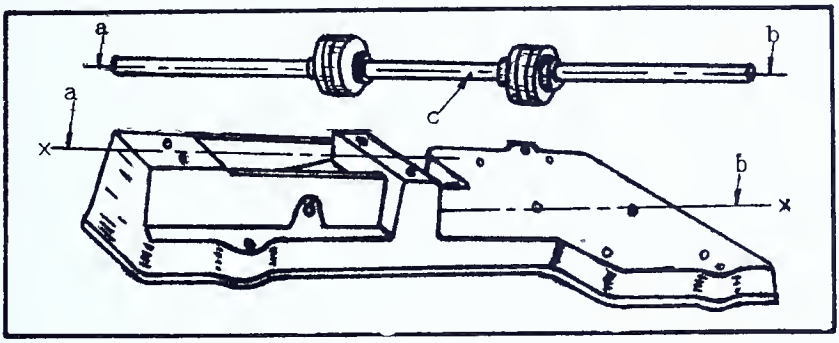


Fig. 170--Alignment of Motor Shaft with Base

The center line of the shaft, which is at right angles to the hori- ntal center line, must also line up with the center line of the foun- tion "x-x". In other words, the shaft must be lined up straight and ue when viewed from any angle.

As the business of building and equipping the ship progresses, many rains on the plates, bulkheads, and foundation supports are set up. avy machinery is installed from time to time which adds weight to the ll and causes some distortion of the entire structure. This distor- on is noticeable in previously lined up motors and pumps; it is more ticeable on larger and very heavy equipment.

It is necessary to go over the work and check the alignment several mes before it may be finally approved by the inspectors. Small pieces equipment do not require this repeated checking.

In addition to distortion caused by added weight, there is the oblem of temperature to be considered. Ships are built in cold ather as well as in hot weather. The temperature varies during each y to a greater or lesser extent, and this variation is reflected in e length and diameter of shafting.

Consequently when an installation is lined up and checked and found be perfect, it does not mean it will stay that way. This statement plies particularly to the line shaft from propulsion motor to pro- ller. If the job is checked at noon one day, it should be checked at on every day. Always check at the same time of the day.

When bearings are tightened up and couplings are bolted tightly gether, there is always danger that heat, generated by friction, may ell the material and cause "hot spots". This is one of the reasons at all such alignments of units installed must be checked over re- atedly until the ship is finally launched. This precaution applies large, heavy motors.

After the launching, the whole job must be checked again; for when e ship takes the water, new strains and stresses are set up which may ssibly exert a pull on some critical piece of equipment and cause ex- nsive damage to bearings, shafting, and coupling.

Some jobs have flexible couplings at the point where the shaf are connected. These flexible couplings are designed to take up compensate for some slight out-of-line condition between a motor and pump, between a steam turbine and a reduction gear, or between a r duction gear and a motor.

However, if the out-of-line condition is too great, an overstra which will cause excessive wear will be put on the flexible coupli mechanism. When this happens, the flexible coupling will not work smoo ly, jerks and knocks will develop, and finally the unit will have to overhauled and repaired to avoid a complete breakdown. It is impossi to use too much care in lining up any of these units.

After the fitter gets the pipes connected to a pump or to a st turbine, these units should not be moved for lining up the drive sha There are two reasons for this. First, it is very difficult, if r impossible, to move one of these units after the pipes are connecte Second, even if the unit could be moved or if the attempt was mad some of the pipe joints could be damaged and cause expensive leak Such damage would mean serious trouble, perhaps at a very critical m ment.

Set the pump, or steam turbine, first; then have the piping conn ted. Always line the motor up with the pump, or with the steam turbi There are no pipes to hinder the aligning.

The electric cable connections are flexible and may be moul without hindrance to the aligning job. Ask the instructor to expl this particular point for a thorough understanding of the operation.

Aligning a Coupling

INFORMATION

Pumps, motors, turbines, and exciters are coupled with each ot in combinations of pump and motor; turbine, motor, and exciter; exci

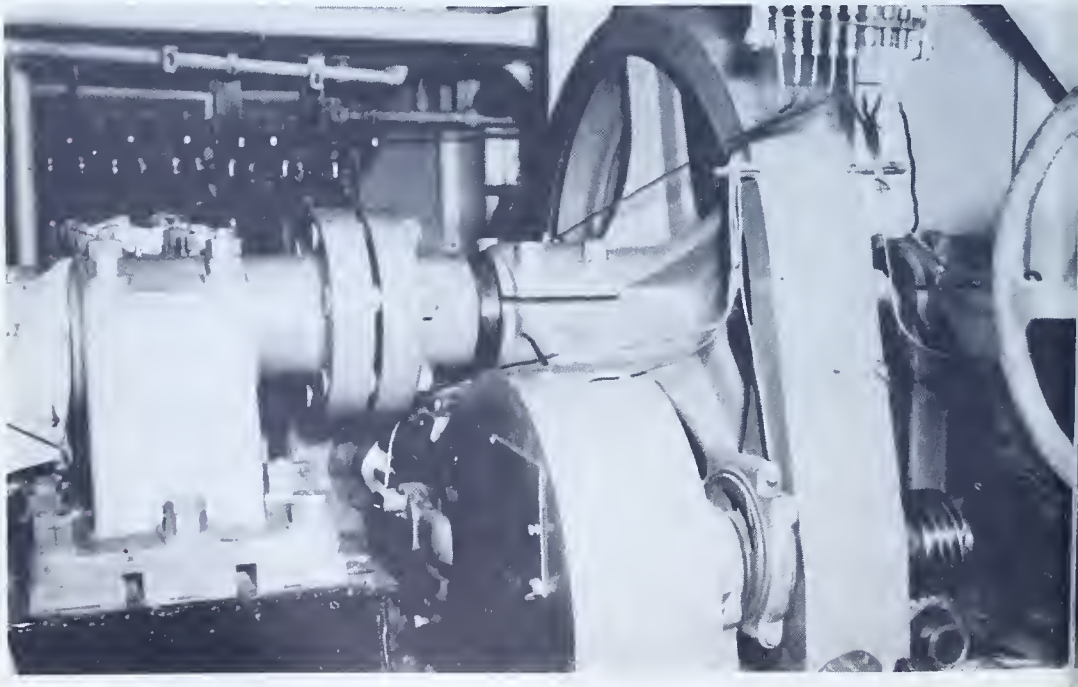


Fig. 171--Line Shaft Connected with Couplings

nd motor; etc. Each unit must be lined up so that the main shaft axle) will run exactly in line with the main shaft of the unit with nich it is connected. This connection is called a coupling. The ends ? two shafts, with the coupling on each shaft end are shown in Fig. 71. This particular job is the line shaft coupling at the forward end ' a steam steering mechanism.

Notice the wedges under the bases of the pump and the motor. Fig. 71-A. These wedges are placed all around the units to be installed in ich a way that there is no interference with the operation of fitting ie chocks after the entire unit has been leveled on the foundation. If ie foundation is level, the operation of setting up the installation may 'oceed at once. If there are rough spots, bumps, or uneven places on ie foundation, they must be leveled off with the portable grinder. ieck very carefully with a straight edge and a level.

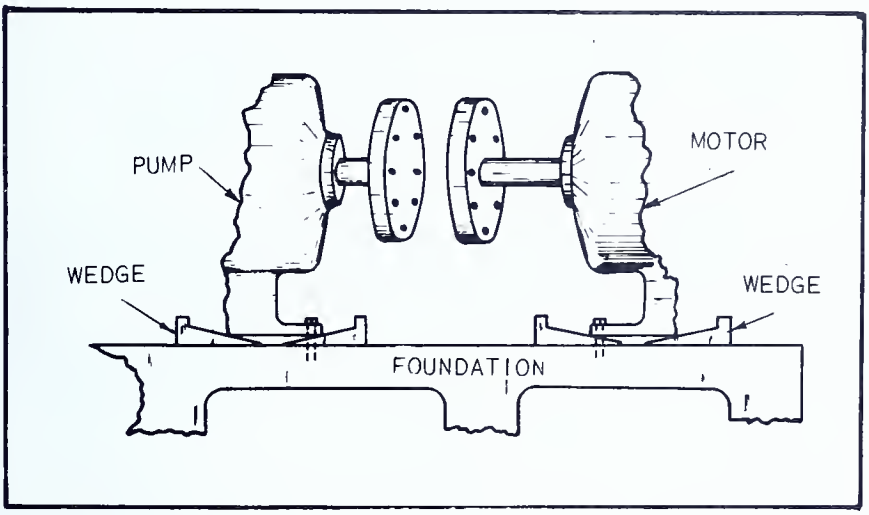


Fig. 171-A--Leveling an Installation with Wedges

When installing turbine generator sets, pump and motor sets, etc., ver attempt to shift the pump or the turbine to align the coupling ter the pipe fitter has done his job of connecting the necessary pip- g. Always make any adjustments necessary by shifting the motor.

On many large installations, such as turbine generator reduction ar jobs, the manufacturer of the equipment sends a man along to super- se the work. Do not attempt to set the pump or motor until the foun- tion is level.

Sometimes, instead of wedges, it is possible to use several pieces steel about one inch thick placed under the bases of the units to be stalled. Jacking screws are sometimes used to level the unit. When e motor or pump, or both, have to be shifted sidewise in order to ign the couplings, side jack brackets are welded in convenient spots the foundation, and large set screws are used to shift the unit side- se or endwise.

Thin shims may be used under the steel packing blocks to bring the uplings into proper alignment. It should be clearly understood that e aligning of couplings begins at the time the measurements are being ken for the chock sheet.

When the chocks are fitted and the units are finally bolted down securely, the couplings must be in perfect alignment. Shims are not used. Each chock must be well fitted so that the bolting-down process will not pull the couplings out of line.

TOOLS

1. 6" scale
2. Dial indicator
3. Thickness gauge
4. Outside calipers

MATERIALS

Steel blocks
Wedges
Side jacks
Set screws
Shims

All of the foregoing may be summed up as follows:

GENERAL PROCEDURE

1. Check the foundation with level and straight edge. (Grind off any uneven spots with portable grinder.)
2. Set unit on blocks or wedges, and level with foundation at the location specified on the foundation drawing.
3. Have side jacks welded to foundation to provide means for adjusting the unit sidewise or endwise.
4. Break the coupling (remove the bolts from the coupling flanges between the units being installed in order to check the alignment of the coupling flanges.
5. Adjust wedges (or other packing that is used) until the outside diameters and faces of the coupling flanges run true when revolved by hand.

METHOD OF CHECKING ALIGNMENT

USING A 6" SCALE

Check the distance between the faces of the coupling flanges at 9 degree intervals; that is, find the distances between faces at point "a" (Fig. 172), "b" (on the opposite side), "c", and "d" (opposite "c").

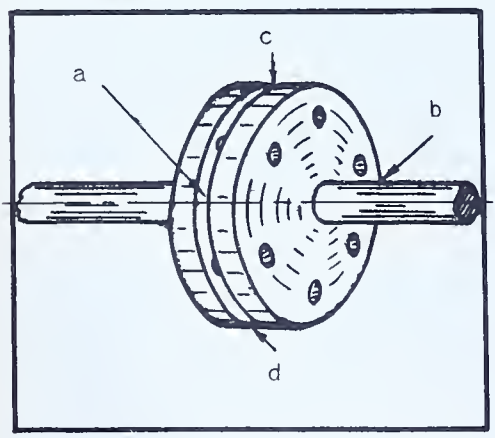


Fig. 172—Aligning Coupling Faces

This will show whether or not the coupling faces are parallel with each other. If not parallel, adjust the motor or pump, using shims, until the couplings check true. The instructor will demonstrate the checking of these distances.

At the same time that step "a" is going forward, the outside diameters of the coupling flanges must be kept in line. Use the scale, placed across the two flanges as shown in Fig. 173.

If the flanges do not line up, it will be necessary to raise or lower one of the units and perhaps shift it sidewise by means of the jacks which were welded on the foundation.

The scale should be tried at intervals 90 degrees as was done when checking ween the faces of the flanges.

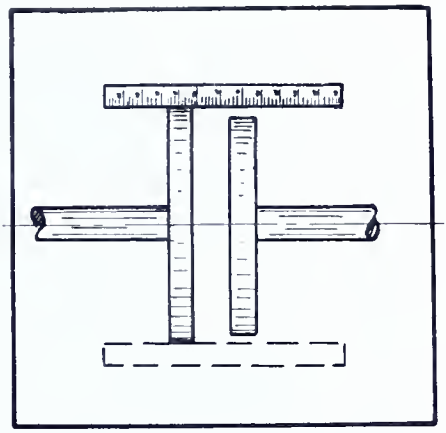


Fig. 173--Aligning Flange Diameters

'HOD OF CHECKING ALIGNMENT
NG THE THICKNESS GAUGE

When the thickness gauge is used, the ›cedure is much the same as when using scale. When the outside diameters of coupling flanges are not the same, use e scale on the surface of the larger ange and try the "feelers" between the face of the smaller flange and the edge the scale.

The distance between the coupling flanges may be checked with the thickness gauge when the space is very narrow. See Fig. 174. Wider spaces are checked by using a piece of square key-stock and the thickness gauge.

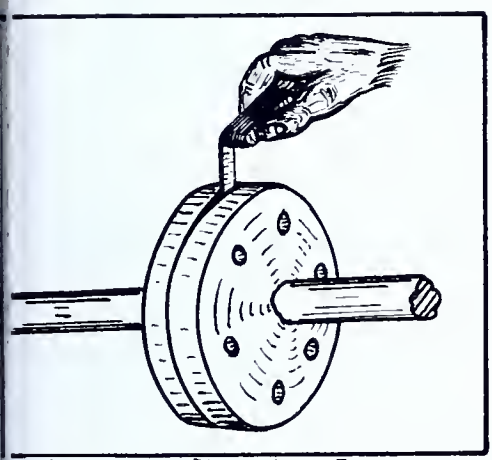


Fig. 174--Checking Faces with "Feelers"

The couplings may be revolved, one at a time, and checked in several positions to find if the faces are true with the shaft. This is usually done at 90-degree intervals. If the faces are not true, the reason is that the shaft has been sprung. In this case check with the instructor or leader. Many times the shafts have to be taken out and sent to the machine shop to be re-worked.

THOD OF CHECKING ALIGNMENT
ING AN INDICATOR

When the dial indicator is used, clamp the indicator to one coupng flange and revolve the opposite coupling. If the indicator shows variation, the coupling is running true.

Revolving the coupling with the indicator clamped fast while the posite coupling stands still will show how much the coupling centers e out of line. Then an adjustment is made, and the job is checked ain.

NOTE: A dial indicator should be used wherever possible when aligning a coupling. It is well to attach an indicator and check the alignment of some units before installing. Cargo pumps are always installed after checking with the indicator.

6. After the chocks are fitted, call the inspector for chock and alignment inspection.
7. If the inspector gives his approval, pull the bolts down tight.
8. The job is again inspected thoroughly. If the second inspection shows the job to be satisfactory, dowels are fitted through the

unit bases to prevent any chance of the shafts' getting out alignment. Check with the leader at this point.

9. After the dowel job is completed, install and tighten the cou ing bolts securely.

GENERAL PRACTICE

The foregoing procedure is general practice. Different types installations call for special methods of handling. For each particul job, arrangements are made to take care of unusual situations. The fi check on motors, pumps, and turbo-generators is made after all pipi is completed, no matter what the installation may be.

Check with the leader at every move. Be extremely careful to ma perfect fits. The mechanic must have a lot of patience as well as ski and he must be an honest workman.

QUESTIONS

1. What is the objection to setting a motor and aligning a pump with the motor?
2. Explain how this job of aligning a pump and motor should be done.
3. What causes a pump and motor unit to show misalignment after all the foundation bolts have been pulled down tightly?
4. Name some of the causes of an installation's aligning satisfactorily one day but being found badly out of line two or three days later.
5. Explain why several inspections may be necessary before the installation can be approved.
6. State the purpose of flexible couplings between driving shafts.
7. Explain what happens to a flexible coupling if the installation is badly aligned.

Overhauling a Pump

DESCRIPTION OF A HORIZONTAL, DUPLEX, STEAM-DRIVEN PUMP

The illustration, Fig. 175 shows a horizontal, steam-driven, dupl pump. This type of pump is commonly used for pumping bilge water a may be used in some cases for pumping cargo (oil). The size of the pu is usually stamped clearly on a name plate affixed to the pump. For e ample: 6" x 4" x 6". The first Figure (6) is the diameter of the cyl der on the steam end; the second Figure (4) is the diameter of the li uid cylinder; and the third Figure (6) is the length of the stroke.

In viewing a horizontal pump from the steam end, the cylinder the right is the right-hand cylinder; the cylinder to the left is t left-hand cylinder. Complete details are shown in cross section, Fi 187 and 188.

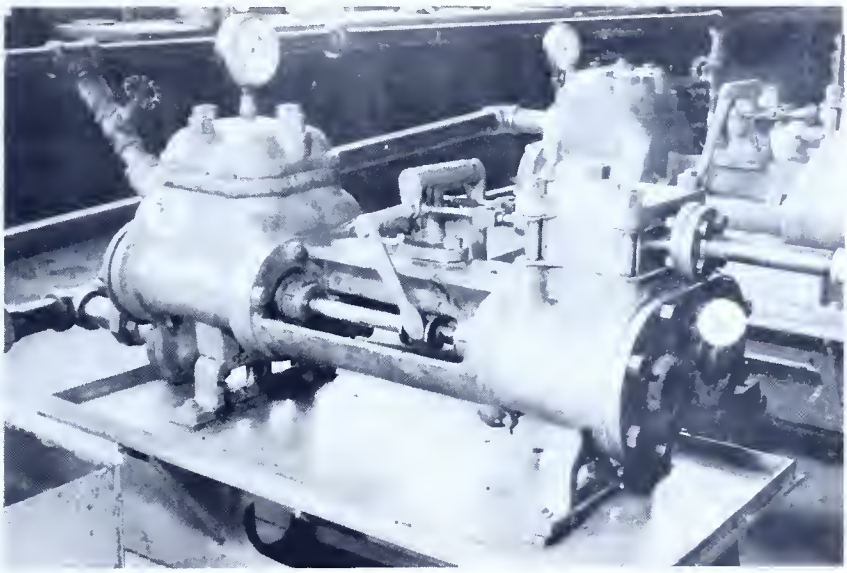


Fig. 175--Horizontal Duplex Steam Pump in Operation

A single-cylinder, horizontal pump is listed as a Horizontal Simplex; a single-cylinder, vertical pump is listed as a Vertical Simplex; the twin-cylinder vertical is listed as a Vertical Duplex. As the name "duplex" implies, the cylinders are twins; there are two cylinders side by side at each end. The driving end where the steam enters is called the "steam-end". See Fig. 175 at "a". The pumping end, through which oil or water is pumped, is called the "liquid-end". See Fig. 175 at "".

The steam enters the steam chest through inlet 1, Fig. 176, placing the chest under pressure. The steam passes into the cylinder by way of inlet port 39, Fig. 176, forcing the piston forward. At the same time, the piston in the adjoining cylinder is moving in the opposite direction. This alternate action produces a constant flow in the liquid-end of the pump.

The valve in the steam chest, Fig. 176 at "3", is termed a flat-faced, D-type slide valve and is called a direct action valve because it is connected by links to the opposite piston rod. It will be noticed that the D-valve has no springs or other mechanical devices to maintain the seal with the mating port faces. This seal is insured by the pressure of the steam in the chest acting on the back of the valve area, pressing it tightly to the seat. For example; the pressure the time at the ports open would be 100 lbs. The area of the valve backs is 7 square inches. Then the force tending to hold the valve to the seat would be 7 x 100, or 700 lbs., plus the weight of the valve. It should be clear that no mechanical pressure is necessary to seal the valve.

As each steam piston makes a stroke, the plunger on the liquid-end is forced ahead or back because the steam piston and the liquid-plunger are mounted on opposite ends of the same rod. See Fig. 176 (Cross section).

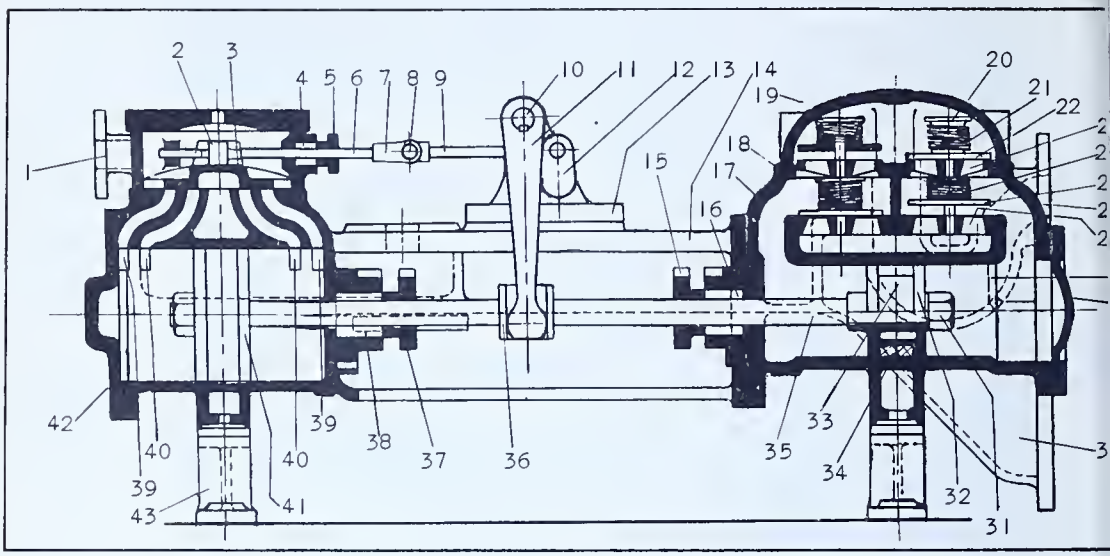


Fig. 176--Horizontal Duplex Steam Pump Longitudinal Cross Section

NOMENCLATURE OF PARTS
HORIZONTAL, DUPLEX STEAM PUMP

1. Inlet to Steam Chest
2. Valve Nut or Tappet
3. "D" Type Slide Valve
4. Valve Rod Stuffing Box
5. Valve Rod Stuffing Box Gland
6. Valve Rod
7. Valve Rod Knuckle End
8. Valve Rod Knuckle Pin
9. Valve Rod Connecting Link
10. Cross Shaft
*11. Lever (See Note)
*12. Crank (See Note)
13. Cross Shaft Stand or Pedestal
14. Cradle
15. Liquid Piston Rod Stuffing Box Gland
16. Liquid End Stuffing Box
17. Liquid End Cylinder Casting
18. Discharge Valve Plate or Diaphram
19. Discharge Cap or Head
20. Discharge Valve Spring Guard
21. Discharge Valve Spring
22. Discharge Valve Disc
23. Discharge Valve Seat
24. Suction Valve Spring
25. Suction Valve Disc
26. Discharge Outlet
27. Suction Valve Seat
28. Liquid Cylinder With Pressed in Liner of Bronze
29. Liquid Cylinder Head Cover
30. Suction Inlet
31. Piston Follower Nut
32. Piston Follower
33. Piston Body
34. Li quid Piston Rings (Hydrauli Duck-Metallic or Rock-Har Fibrous) Depending on servi
35. Piston Rod
36. Piston Rod Spool or (Threaded Split-Type Crosshead)
37. Steam Piston Rod Stuffing Bo Gland
38. Steam Piston Rod Stuffing Bo
39. Steam Inlet Ports
40. Exhaust Ports
41. Steam Cylinder Piston With Cast Iron Rings
42. Steam Cylinder Head
43. Supporting Bases

*NOTE: *Levers and Cranks*

A long lever on right side connect to long crank on left side to lef steam cylinder valve.

A short lever on left side connec to short crank on right steam cy inder valve.

STON ROD MOTION

The motion of the ston rod is controlled the slide valves in steam chest. See Fig. 7 At "c-c". The slide lves are so adjusted at the steam is admit- d to one end of the linder to force the ston in one direction. e Fig. 178. The slots the cylinder body at e base of the steam est are the steam ports. ots "a-a" are inlet ports, on each end of the cyl- ier which makes it double-acting. Slots "b-b" are exhaust ports. Slot is the main exhaust port, cored through the casting to exhaust dis- arge connection. The mechanic is holding a slide valve in each hand "d" and "e" in Fig. 178.

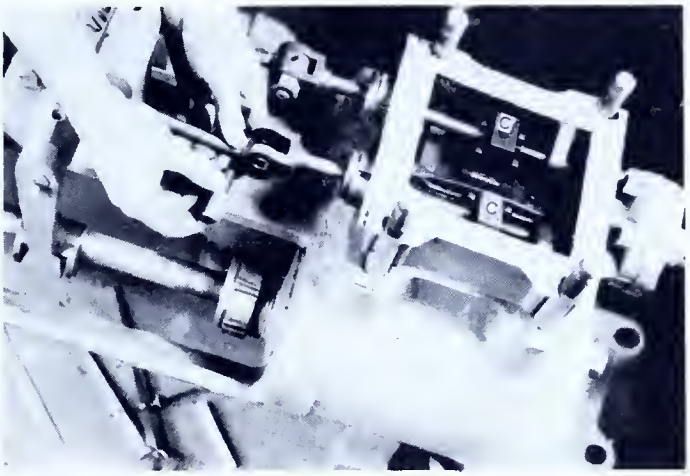


Fig. 177—Adjusting Valve Slide Rods

LVE TAPPET

The valve nut or tappet, Fig. 176 at "2", is placed between the two U-shaped lugs shown on the back of the slide valve in Fig. 178 at "d". The tappet is narrower in width than the space between these lugs, giving a designed lost motion, usually 1/2", the width of the inlet port on each side of the nut. When the valve is set in central position or dead center as in Fig. 176, it is in position for adjustment. This condition can never occur in actual operation because every port (inlet) is closed.

Fig. 178—Checking Valve Slide for Fit

This lost motion designed in slide valves is provided to eliminate a positive "dwell" on both cylinders simultaneously, which uld give a pulsating action to the water discharge. The lost motion eps one piston in motion at all times, eliminating the undesirable rge which would be caused by the overlapping action.

As this sequence of motion continues, the plunger in the liquid-end the pump forces the water or oil to move in a continuous flow. This ntinuous flow is possible because one plunger is going ahead when the unger beside it is backing up. One plunger sucks the liquid into the amber, and the other plunger pushes the liquid that was sucked in on e previous stroke out of the chamber. Figure 179 shows the liquid-end the pump with the bonnet removed. The mechanic is holding the dis- arge valve plate. One valve stem, valve, and spring assembly have en removed.

PISTON ROD SPOOL

The piston rod carries a spool, Fig. 176 at "36" and Fig. 180 at "f", located in a central position between the steam and liquid ends. The spool is fastened by a tapered, fitted pin and a set screw; and it is cut out to form a U-shaped opening which actuates the valve-operating lever and also prevents the piston rod from revolving. This revolving action will occur if the piston rings bind in the steam-piston grooves. (The action of the steam on the diagonal-cut gaps of the piston rings similar to a screw or twisting thrust as in a Mitchell-Thrust slipp action.)

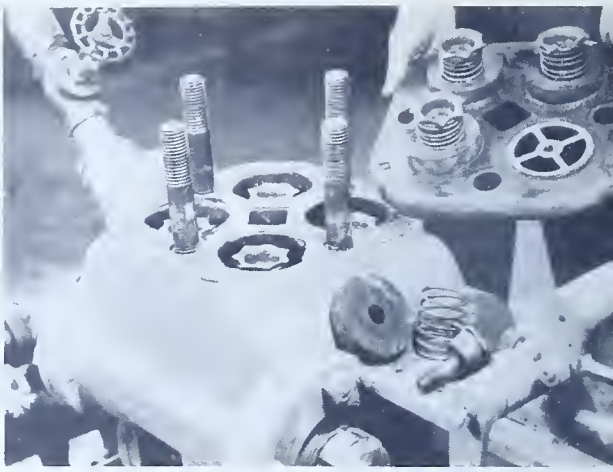


Fig. 179--Liquid End of Pump with Bonnet Removed

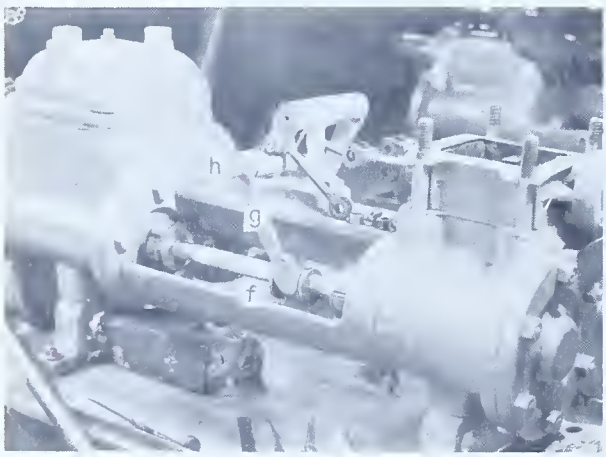


Fig. 180--Horizontal Pump Valve Mechanism

CYLINDRICAL SPOOL

Some pump manufactur use a cylindrical spool with a milled flat as in Fig. 180 "f", and to prevent the pis rod's turning they employ a sl ted extension on the spool wh engages a rib extension. rib extension is cast integ with the cradle casting, dire ly under the piston-rod spo

VALVE OPERATING LEVERS

The upper end of the va operating lever (11, Fig. 1 is keyed to a cross-shaft (Fig. 176). The cross-sha operates in bronze bushings in the cross-shaft stand (13, Fig. 17 The other end of the shaft carries the crank (12, Fig. 176) which is c nected by a pin through the drilled end of the valve rod connecting l (9, Fig. 176). The other end of this link is connected to the for end of the valve rod called the valve rod knuckle end (7, Fig. 1 by a knuckle pin (8, Fig. 176). The tappet (2, Fig. 176) is adjusta on the threaded valve rod (6, Fig. 176) to permit adjustment of sl valves by disengaging knuckle pin and turning the valve rod in or o as required.

SLIDE VALVES

The two valve slides are shown at 1 and m, Fig. 182. Notice 1 sl is forward while the adjoining slide is to the rear. Two steam ports be seen at opposite ends of the steam chest. Figure 185, "n" and "

hows the mechanic making a final check of he valve setting. Note that the pin may be ithdrawn and the link dropped out of the orked end so the valve stem or spindle may e screwed in or out of the valve slide nut o adjust the valve timing.

All of these parts of the pump-operating echanism must be adjusted correctly and kept n good working order or the pump will fail o function efficiently.

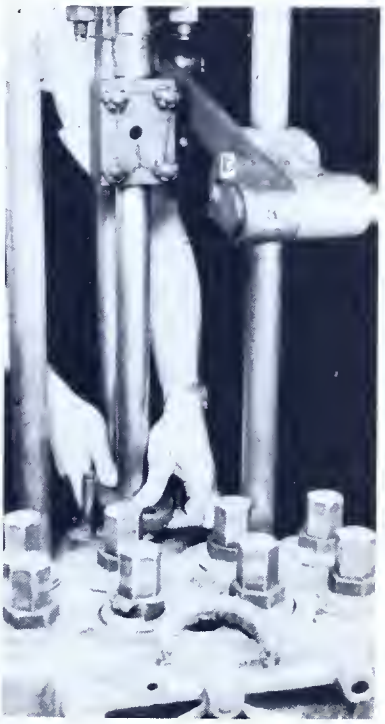


Fig. 181
Vertical Simplex Pump

ERTICAL SIMPLEX

Figure 181 shows a Vertical Simplex pump. he working mechanism is much the same as in he horizontal pump. Both types of pumps re used for similar purposes. The construc- ion of the pump in Fig. 181 does not employ cast cradle, but has three tie rods between he steam and liquid ends. When erecting his type of pump, the mechanic must exercise xtra care in the alignment of the cylinder. he best practice is to align the cylinder ith a tight wire, with heads and recipro- ating assembly removed to facilitate a thor- ugh check.

UMP LIQUID-END

Figure 186 is a view of the liquid-end of a vertical pump. The echanic is fitting a ring of packing material around the piston rod. he gland is directly above and will be used to push the packing ring into the stuffing box to make room for the next ring which is shown lying n the liquid-end valve chest. Figure 181 shows eight large nuts and plugs which are binding bolt, pin, nuts, and lock nuts for suction and discharge valves. These are eight each in number in a monochest con- struction. See Fig. 184.

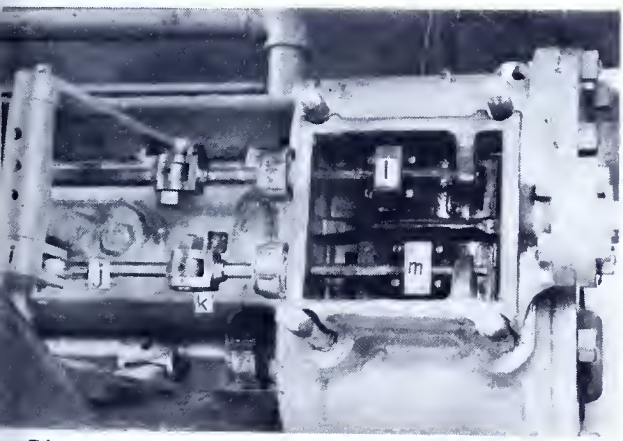


Fig. 182--Horizontal Pump with Steam Chest Cover Removed

VALVE LEVER CROSSHEAD

Figure 181 at "a" shows the valve lever crosshead (split type) which joins the two piston rods. Four bolts and four castellated nuts are used to clamp the crosshead to the piston rods. The bolts are drilled for copper wire which is used as a locking device as shown. Fig. 181 at "b" shows a hole used to connect the valve-operating lever to the auxiliary valve rod by means of connecting link and pins.

OVERHAULING JOBS

Overhauling jobs on a horizontal, duplex pump consist of openi the pump steam cylinder and renewing the piston rings; grinding and r seating the valve slides; adjusting the valves; renewing or reboring t lining in the liquid-end of the pump; replacing badly worn piston roc etc.

As the greater part of this instruction must be given on the j under the supervision of an experienced man, it is considered sufficie for instructional purposes to concentrate on some one overhaul job. T description of a pump already given in the text and the procedure f one example of a pump job should enable the trainee to go ahead with ge eral pump overhauling under minimum supervision.

A typical example of a pump-overhauling job is the work of openi the pump steam cylinder and renewing the piston rings.

PISTON-RING WEAR

Figure 183 shows a piston rod and plunger details. The pist rings must be renewed and new packing must be installed in the stuffi boxes. The plunger rings may have to be renewed. If there is exces ive wear on the piston rod, a new rod is installed. Figure 175 shows piston rod in place with the stuffing box nuts tightened snugly.

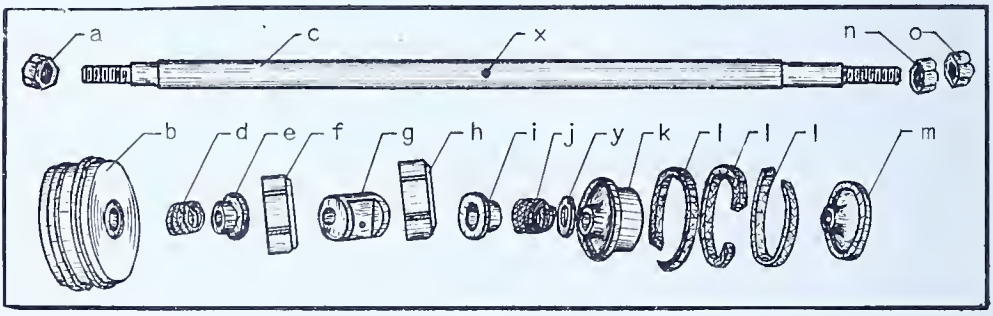


Fig. 183--Piston Rod and Details

Fig. A NOMENCLATURE

Steam End
- a- Castellated Nut (Steam Piston Lock Nut)
- b- Steam Piston with Rings in Grooves
- c- One piece Bronze Piston Rod
- d- Metallic Packing- Cut Rings (steam end)
- e- Stuffing Box Gland
- f- Stuffing Box Gland Nut (Serrated type; Use Spanner Wrench)
- g- Valve rod operating Lever Spool
- h- Stuffing Box Gland Nut
- i- Stuffing Box Gland
- j- Commercial Flax Packing (Braided)
- k- Liquid Piston Body
- l- Hydraulic. Duck (Tuck's packing) Packing Rings:
  Joint Clearance-1/8"
  Joint Angle 45°
- m- Piston Follower
- n- Piston-Follower Nut

o- Piston-Follower Lock Nut
x- Hole in Piston Rod for Operating Lever Spool
y- Washer-seat for packing

The steam piston in a pump has two or more cast-iron rings. When hese rings wear or lose their tension, the steam will pass by them. his reduces the power and efficiency of the pump. It is then nec- ssary to renew the rings. There are several reasons why piston rings ear. Lack of lubrication is the principal reason. A sloppy ring fit hen the pump was first put into operation is a contributing factor. hatever the reason for the wear, it is essential that all the defects e eliminated when the pump is overhauled.

VERHAULING A PUMP

When overhauling a pump of any description, always mark the loca- ion of parts that are to be removed, to facilitate the re-assembling of he unit. Wire all bolts, nuts, and other parts together, and wire the arts to some part of the unit to prevent their being lost.

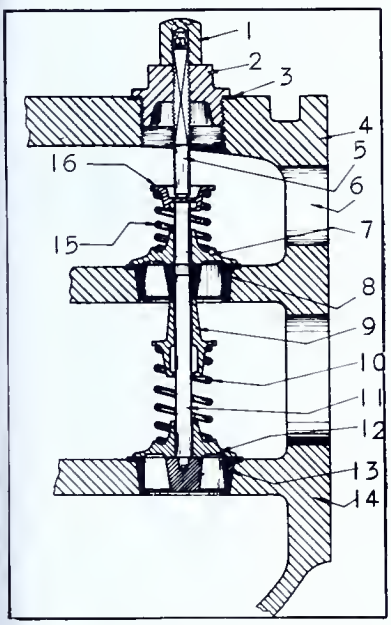


Fig. 184--Monochest Valve Assembly

Nomenclature of Water-End Valve-Assembly of a Vertical Simplex, Steam-Driven Pump (as shown in Fig. 184, "Overhauling a Pump".

NOTE: This type of Valve-assembly is termed *Monochest* construction.

1. Lock nut
2. Binding-Bolt Nut
3. Lead Ring
4. Liquid-End Housing
5. Valve-Guard Binding Bolt
6. Access Hole
7. Discharge Valve
8. Valve Seat (Pressed-in Taper or Threaded)
9. Suction-Valve Guard
10. Valve Spring
11. Valve Guide and Binding Pin
12. Suction Valve
13. Suction-Valve Seat
14. Valve Cover Plate and Gasket on this surface.
15. Valve Spring
16. Discharge-Valve Guard

OOLS AND EQUIPMENT

1. Hammer
2. End wrenches
3. Dividers
4. Center punch
5. Packing hook

MATERIALS

Used Pump
Cast-iron piston rings

The work of the opening up a pump steam-cylinder and renewing the iston rings may be outlined as follows:

PROCEDURE

1. Make sure the valve and the exhaust valve are closed before beginning the overhaul job.

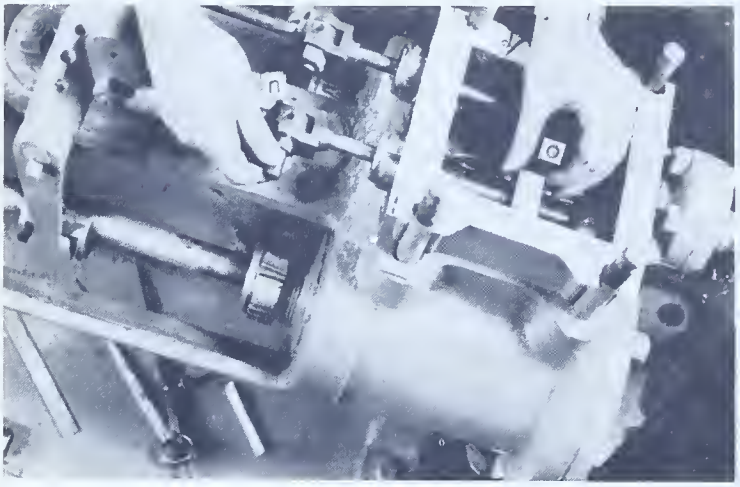


Fig. 185--Checking Valve Slide for Position

2. Open drain valves or bottom cylinder to release steam pressure.
3. Remove nuts from cylinder head with end wrench and hammer.
4. Mark (with punch) cylinder head position in relation to the cylinder. This is done in order to place the head correctly when re-assembling. Remove head from cylinder.
5. Remove nuts from packing gland. Remove gland packing from the stuffing box.
6. Tram crosshead and rod with dividers. Register this setting on some convenient part of the pump foundation so that the setting may be proved when re-assembling the pump. Mark tram point with center punch.
7. Remove tapered pin or lock screw from crosshead.
8. Screw rod from crosshead and remove rod and piston from cylinder.

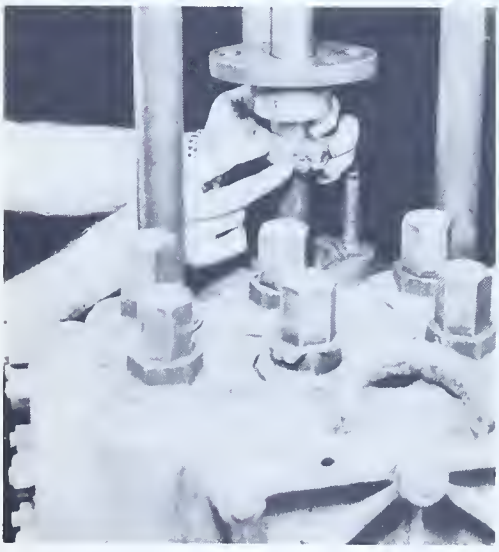


Fig. 186--Pressing Packing into Place

9. Check cylinder, for oval shape and taper, with inside micrometer. If necessary re-bore the cylinder.
10. Take piston to machine shop for truing up ring grooves in lathe.
11. Have new rings made to fit ring grooves and cylinder diameter.
12. Cut new rings with hack saw on 45 bevel.
13. Rings are to be fitted to smaller place in cylinder. Clearance of beveled edges of ring should be between .002" and .003" for each one inch of cylinder diameter.
14. Fit rings to piston. Place piston in cylinder, and screw rod in crosshead to tram marks. Replace lock in crosshead.

15. Replace cylinder head with new gasket. Replace nuts on studs, and tighten with wrench securely.

16. Repack rod stuffing-box with steam packing. Replace gland and nuts. Tighten nuts on gland hand-tight with wrench.

STEAM END AND LIQUID END

The exhaust outlet is larger than the steam inlet. The exhaust outlet is made larger than the steam inlet to prevent any back pressure when the pump is running. The liquid-end inlet or suction opening is larger than the discharge opening. Because of this difference in the size of the inlet and discharge the pump plunger has a surplus source of supply, and consequently a vacuum is avoided in the discharge line.

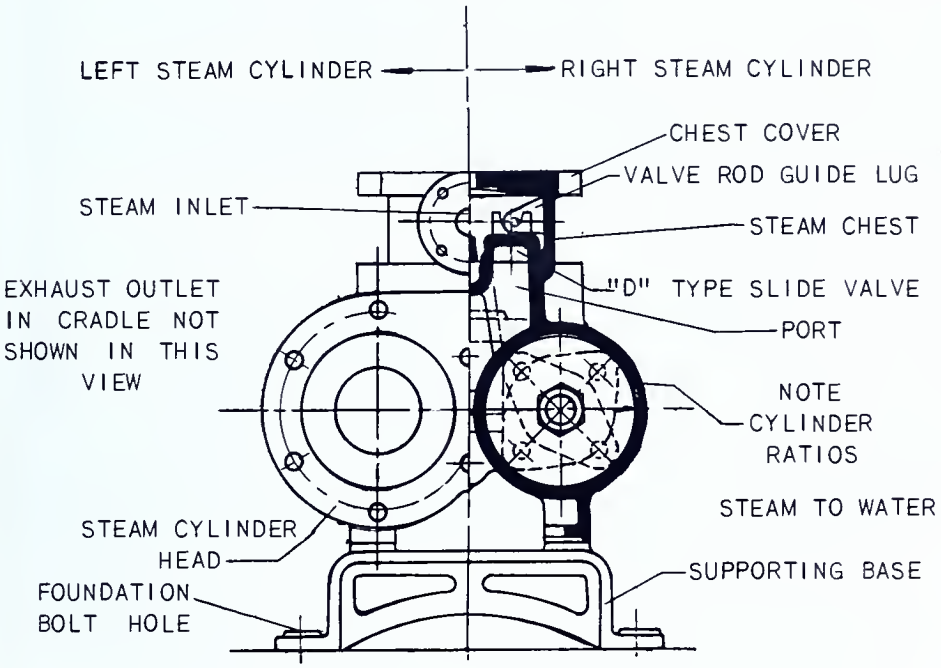


Fig. 187--Cross Section of Steam End of a Horizontal Duplex, Steam-Driven Pump

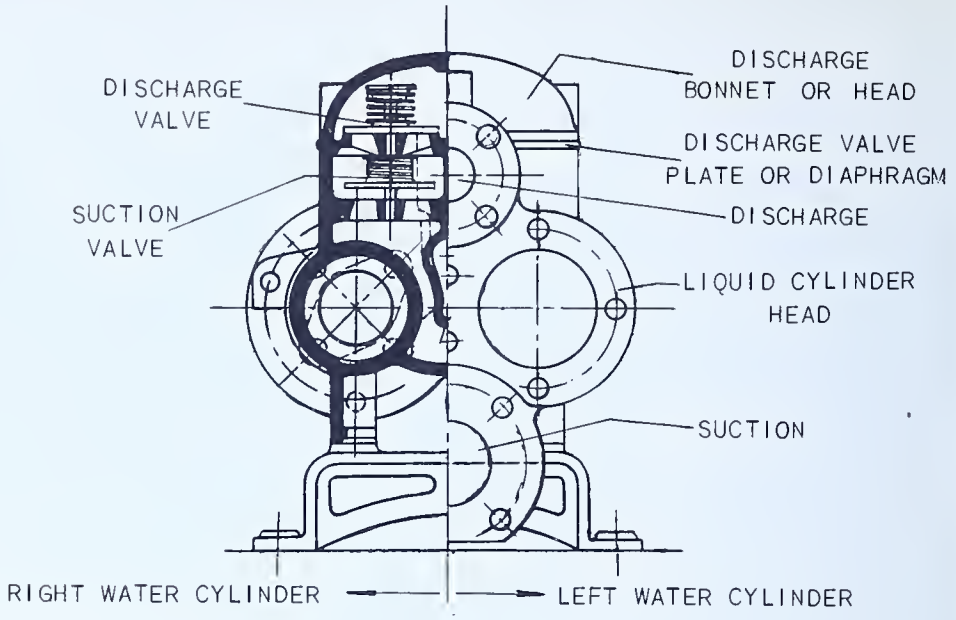


Fig. 188--Cross Section of Liquid End of a Horizontal Duplex, Steam-Driven Pump

QUESTIONS

1. Why is it necessary to check the cylinder with the micrometer
2. State how to determine the steam end of a pump from the liqui end of a pump.
3. Why do rings have to be fitted to the smallest place in th cylinder?
4. How firmly are the packing-gland nuts tightened?
5. Why are tram marks registered on the pump foundation?
6. What is the reason for regrooving the steam piston in the ma chine shop?
7. What is the first thing a mechanic should do when about t overhaul a steam pump?

Spotting and Scraping Bearings

ENERAL INFORMATION

A discussion pertaining to spotting and scraping bearings could be xtended to cover many types and sizes of bearings. It is not thought ecessary to make an exhaustive study of all types of bearings, but enough pace will be given to outline the general shipyard practice followed hen spotting and scraping the connecting rod bearings and journal crank ins which are commonly used in the Sun Doxford main propulsion Diesel ngine.

ORKING PARTS INVOLVED

There are several main rods used in these engines. Two opposed istons are installed in each cylinder. The explosion of the fuel orces the pistons apart. The pistons act on the main connecting rods. he crankshaft ends of the connecting rods are fitted to the crankhaft journal (crankpin) and secured with a heavy cap. The connectng rod is spoken of as having an upper end and a lower end. See Fig. 90.

EIGHTS OF THE PARTS

The crankshaft weighs about 20 tons. Each piston weighs bout 5 tons. Each of the side onnecting rods weighs about 3½ ons. The center connecting rods eigh 5 tons each. When the meanic fits automobile motor conecting rods to the crankshaft earings, he can hold the rod in s hand, and he can lift and carry the crankshaft about in his two nds; but to handle the diesel motor connecting rods, the machinist ust use chain falls or crane.

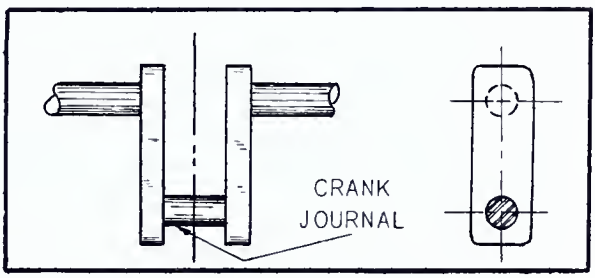


Fig. 189--Journal at Bottom Dead Center

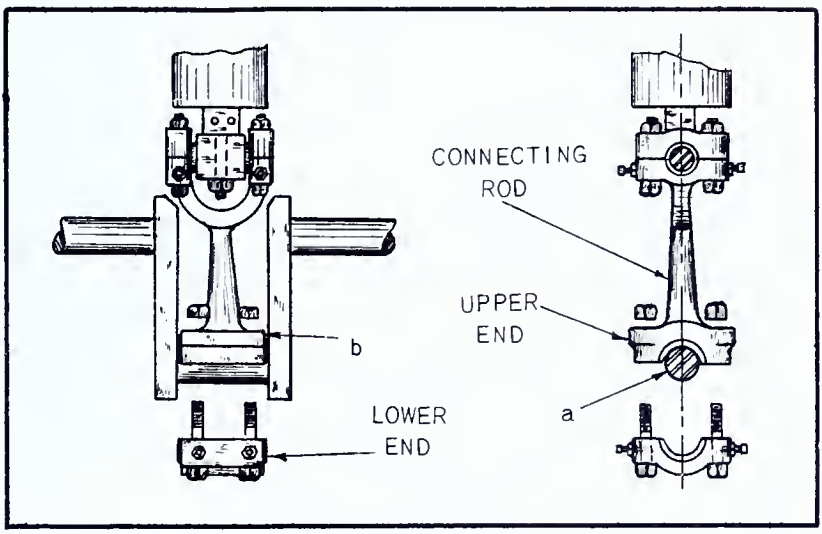


Fig. 190--Connecting Rod Assembly

THE WORKMAN'S RESPONSIBILITY

The work involved on this job is of an advanced nature. Workmen are selected for their job because they have proved their mechanical ability on previous jobs. It is, then, the duty of each workman to consider each move carefully; to take no chances which could result in injury to himself or to others; and to work accurately and conscientiously. The final functioning of a diesel engine reflects the mechanical ability and the integrity of the workmen who assembled and fitted the several parts.

TOOLS AND EQUIPMENT

1. Spoon scraper
2. Flat scraper
3. 6" Thickness gauge
4. 12-point box wrench to fit lower end nuts
5. Center punch
6. Machinist's hammer
7. Pin snips
8. 3' Pinch bar
9. 1" mikes
10. 20-lb. maul (sledge)
11. 2 1-ton chain falls
12. 1 3-ton chain fall
13. Electric drop extension cord (30' or longer)
14. End scraper

MATERIALS

Prussian blue
Lead wire, .018" in diameter,
Shim stock, .002, 005, .010.
Cleaning fluid
Clean rags
Cup grease
Lead cards

PROCEDURE:

1. Turn the crankshaft so that the crank journal to be fitted is on the bottom, dead center. See Figs. 189 and 190.
2. Have the riggers lift the rod from the crankshaft.
3. Clean the crank journal, and stone any rough spots that may be evident.

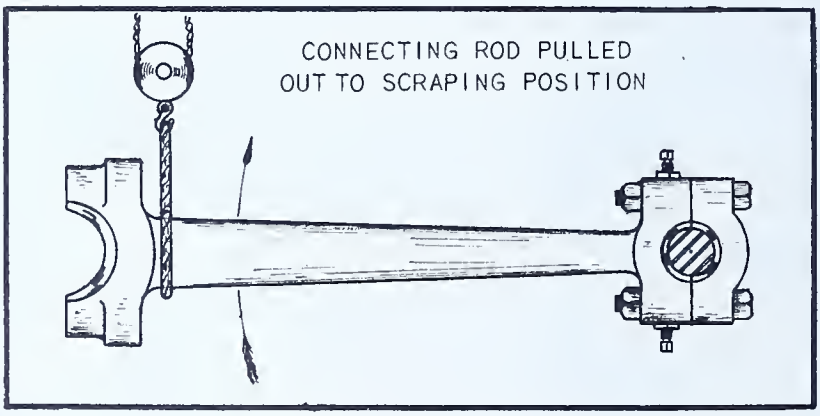


Fig. 191--Chain Fall Holding Connecting Rod in Place for Scraping

4. Clean the top half of the rod bearing.
5. Blue the crankshaft with a light film of Prussian blue. Apply it evenly and smoothly with the fingers.

6. Lower the rod on to a crankpin. Do not allow the horns of the bearing to contact the crankpin. The hollow end of the rod must contact the crank much after the same fashion as when a saddle is placed on a horse. See Fig. 190-"a".

7. When a jacking gear is available, it may be used to "rock" the rod back and forth on the journal to spot the bearing. This motion is the same as the actual operation of the rod-bearing on the journals. When a jacking gear is not available, use a pinch bar between the end of the rod bearing and the side of the crank throw, and "bar" the rod end over toward the opposite side. Change the position of the pinch bar, and "bar" the rod end back to its original position. Repeat several times. See "b", Fig. 190.

NOTE: Do not allow the chisel edge of the pinch bar to ride the fillet in the corner of the crankpin and crank throw

8. Lift the rod with the 3-ton chain fall.

9. Pull the rod out to scraping position with the 1-ton chain fall. See Fig. 191.

10. Adjust the crop light in position to see the high spots on the bearing clearly.

11. Study carefully the blue markings which will appear on the bearing surface, and pick out the highest high spots.

12. Concentrate on the highest high spots; and with the spoon scraper remove only the blue spot, using a smooth, even stroke. The scraping action should start easily and lightly, follow through the center area of the high spot firmly and slightly deeper than on the start, and finish out on the opposite side easily and lightly. This action tends to "cup" the high spot area and level it with the surrounding surface. This must be thoroughly understood.

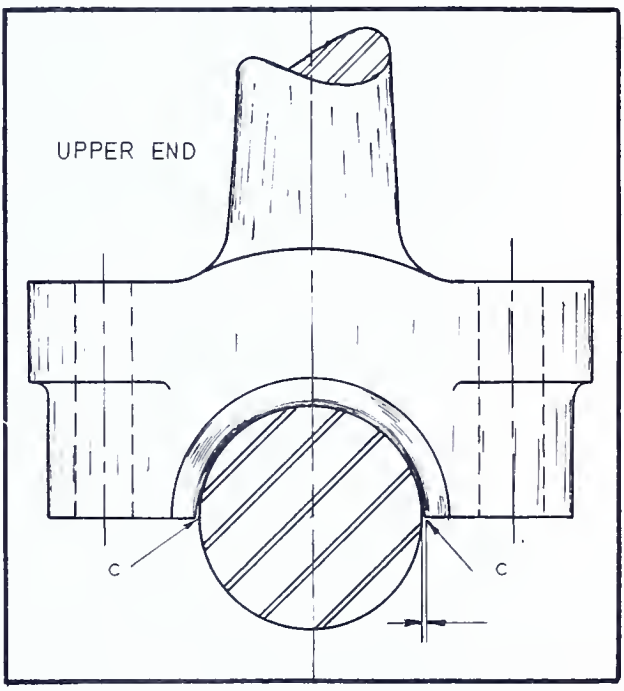


Fig. 192--Upper End of Connecting Rod Fitted to Journal

13. Release the 1-ton chain fall, and allow the rod to swing back over the crankpin.

14. Re-blue the crankpin, or redistribute the blue evenly on the pin.

15. Lower the rod onto the crankpin as in Step 5. Repeat the bearing operation as in step 6.

16. Raise the rod as in step 7, and proceed as in steps 10 and 11.

NOTE: Repeat these operations until the surface of the bearing is uniformly level. After each scraping with the spoon scraper use the straight, or hand scraper, to "straighten off" several high spots, and thus bring the bearing into line more quickly and uniformly.

RELIEVING THE HORNS

The horns of the bearing must be relieved for a distance of approximately 1/10 of the circumference of the crankpin. See Fig. 192 at "c-c". The clearance at the center line of the pin must not be over .007 of an inch and not less than .005 of an inch tapering to nothing. This relieved position must be very accurately determined.

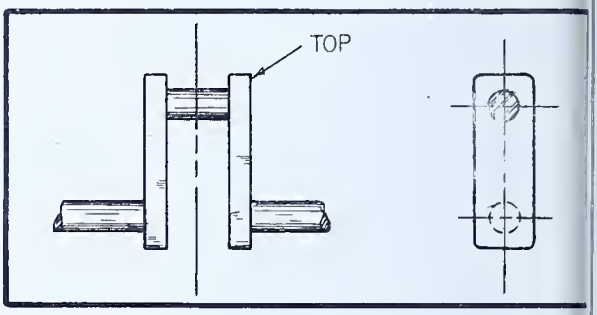


Fig. 193--Journal at Top Dead Center

Check the relief with the feeler gauge. The gauge must be at least 6" long. When the upper half of the rod is fitted, proceed to fit the bottom end. Remove all blue from the crankpin, and apply a liberal coating of cylinder oil all over the crankpin.

17. Reverse the position of the crankshaft. Bring the crank journal that is to be fitted, together with the rod, to top dead center. See Fig. 190 and Fig. 193. They are different.

18. Clean the rod "bottom end"; remove any rough spots; and make sure that the shims are of equal thickness on both sides and securely fastened.

19. Slide the "bottom end" into the crankpin. Lock the "bottom end" bolts securely.

NOTE: The bolts are locked by means of set screws through the walls of the bottom end. The bolts are drilled and tapped in the nut end for eye bolts. See Fig. 194. Eye bolts are screwed into the rod bolts, and a suitable chain-fall hook is used to pull the bottom end up to the desired position on the crank journal. The weight of the rod holds the upper half of the assembly in place. The upper end of the rod is securely held and needs no further support.

20. With the bottom end of the rod hanging on the bottom-end bolts lay six lengths of lead wire in the bearing half. The lead wires should extend from horn to horn of the bearing. See Fig. 195.

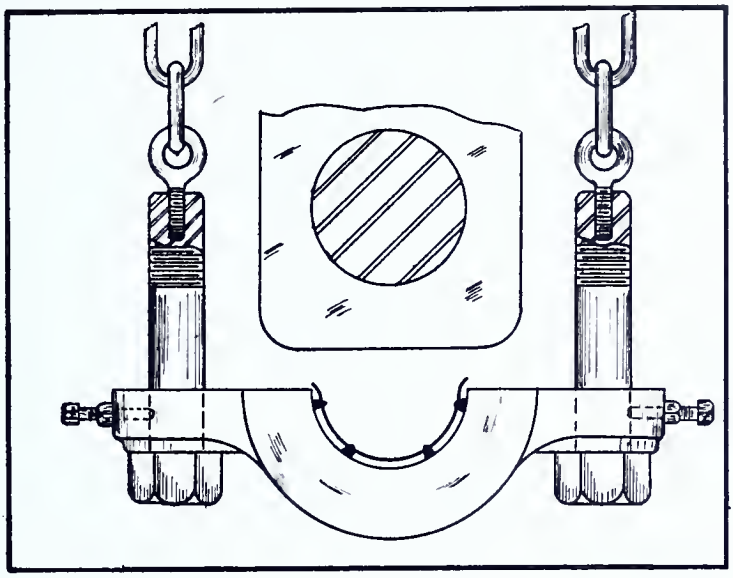


Fig. 194--Pulling the Bottom End Up to the Journal

21. With the lead wires in position, apply a little cup grease at intervals to hold the wires in place as shown in Fig. 195.

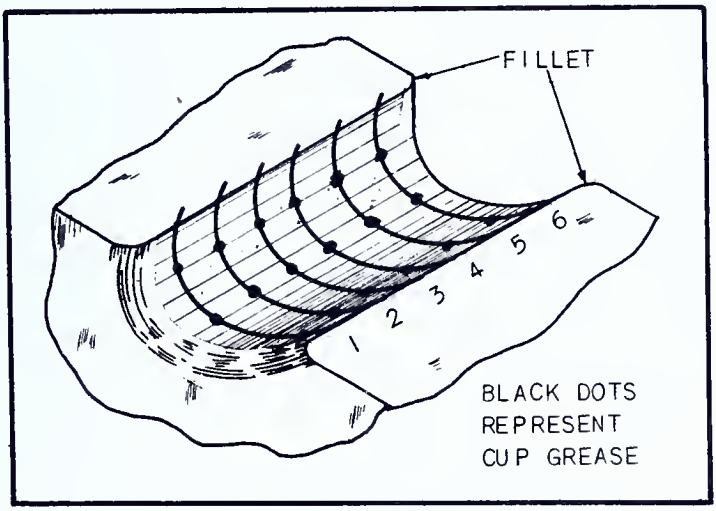


Fig. 195--Lead Wires Held in Place with Grease

22. Pull the bottom end up to the crankpin, and tighten the nuts securely, using a heavy wrench and a 20-lb. maul. The nuts must actually be driven on so tight that a blow of the sledge gives off a sound as though it were striking on solid metal.

23. Mark the end of each bolt and the face of each nut with a center punch to register the position. This is done so that the nut can be tightened to the same position again. See Figs. 196 and 197.

24. Loosen the nuts, drop the "bottom end" down clear of the crank.

25. Mark the opposite sides of the bottom end with the position of the leads from 1 to 6. See Fig. 195.

26. Remove the forward lead, and fasten it to the forward position on the lead card. Repeat with all the leads in order, forward and aft. Fig. 198.

27. Mike the leads. Check with the leader to see whether the seals are to be open or closed. See Fig. 199.

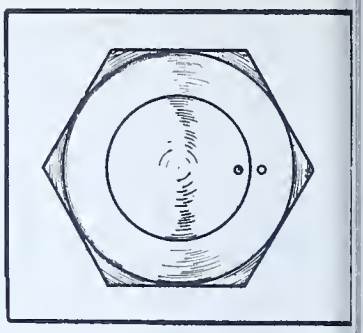


Fig. 196--One Punch Mar

NOTE: There should be .010 to .012 of an inch clearance be tween the crown of the bearing and the cran pin. Check with the leader to find if this i correct. If not correct, relieve the horns c the bearing for sufficient clearance. Then with the leads in a position where the mechani can readily check for comparison, remove a shi if necessary.

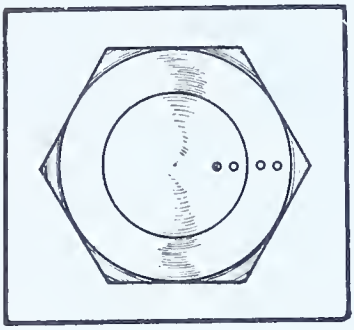


Fig. 197--Two Punch Marks

28. Use a new set of leads, pull the bottc half up as before, and snug home.

29. Remove the bottom half, and repeat th check for clearance as before. Check wit the leader.

30. If the leader approves, thoroughly clean the bearing sur face and the crankpin surface. Apply a liberal amount of cy inder oil to both bearing surfaces, and bring the bottom er home as in step 22.

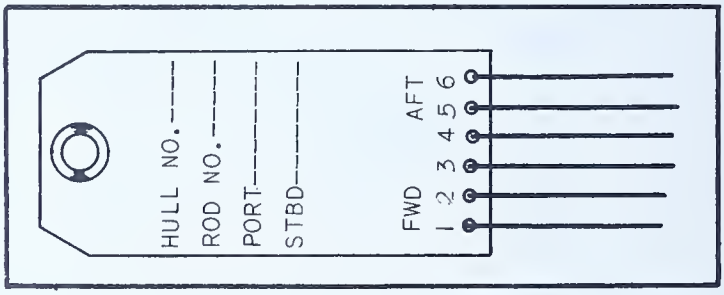


Fig. 198--Leads Fastened to Lead Card

NOTE: When the machinist is spotting and fitting main bear ings, the crankshaft journal is blued all around. Th crankpin is rotated in the bearing to find the hig spots; the scraping of the bearing is done as explain above; and the bearing cap is drawn up tight and check with leads for clearance. Cleaning and greasing ar followed through as before. The operation of spottii and scraping main bearings is practically the same a the operation of spotting and scraping crankpin bear ings. The crank is rolled in the bearing and the

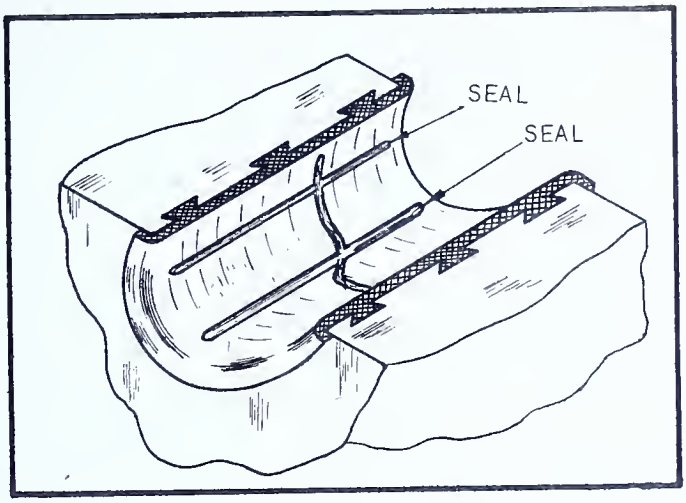


Fig. 199--Oil Grooves in Bearing Half

picked up while the bearing is scraped. Circumstances govern these procedures.

Installing Operating Rods

'OSE OF OPERATING RODS

Operating rods are installed after the deck stands are in place. operating rod is the connection between the deck stand wheel and the 've in the hull of the ship. See Fig. 201 and Fig. 206.

AIGHT OPERATING RODS

Sometimes the rods hang straight, and sometimes they are offset to ar an obstruction. When the rods hang straight, they are "stepped" 'e they are joined together, and a straight coupling is placed on the rating rod at the step joint. See Fig. 202. On new work, brackets supports are welded to the bulkhead to hold the split bearing, ch is usually brass. See Fig. 203. On repair work, because of the sible presence of gases, permission must be obtained from the plant nist before welding or burning.

SET OPERATING RODS

When the operating rods are offset and do not hang straight, the ve is installed in the hull at the proper place; the deck stand is ied to the weather deck at the proper place; and then lines are run letermine the position of the offset in the operating rod. See Fig. which shows deck stands and valves in place with the operating s installed between them.

TALLING OPERATING RODS

Figure 203 shows part of an operating rod hung on a corrugated khead by a brass bearing held in an angle clip and supported by steel ts welded to the bulkhead. Figure 204 is the angle clip, which is cted to allow the operating rod to be slipped into place; it is drilled natch the bolt holes in the brass bearing.

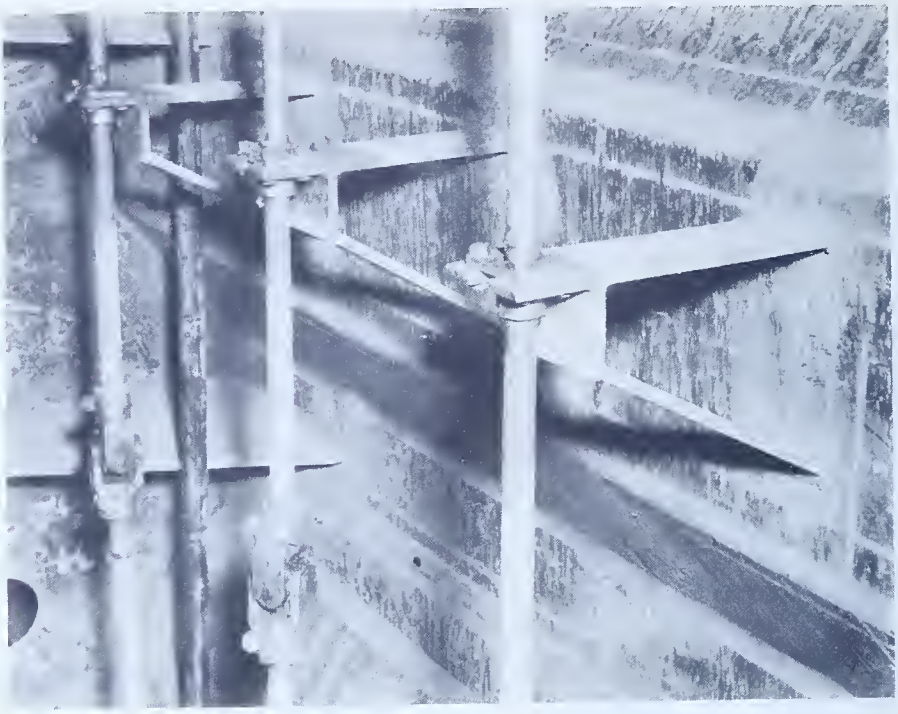


Fig. 201--Operating Rods Installed on a Bulkhead

Figure 201 shows an operating rod installation with the two rods on the left equipped with universal joints. Notice the extremely lo space between the universals and the brackets which support the rod This is very poor practice and should be avoided. It is considered go practice to place the support bracket as close as possible to the uni versal or coupling. See Fig. 206 at "a".

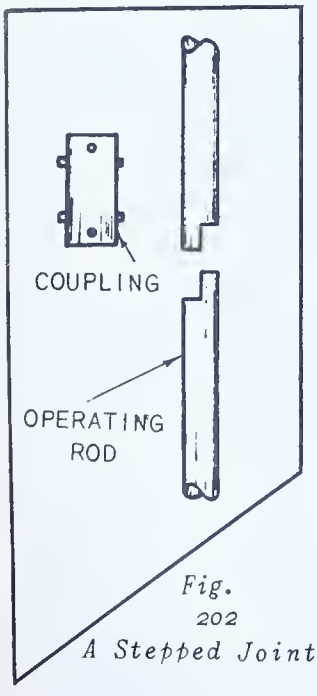


Fig. 202 A Stepped Joint

Standard length rods are used wherever poss ble, but certain conditions make it necessary t use rods that are not standard length. In some i stances the top rod is the one that departs fr the standard length because it is fitted last a therefore must be cut to suit the distance betwe the top end of the last rod installed and the e of the deck stand stem below the weather deck. other instances the bottom end of the bottom rod a the end of the fork that connects with the valv yoke is fitted last.

The supporting brackets (Fig. 203) are welde to the bulkhead corrugation which is nearest to t jointed ends of the operating rods. (Fig. 206 Sufficient space must be left between the end the coupling, or universal and the top of th angle which supports the brass bushing to enabl the workman to insert the operating rod through t hole in the clip (Fig. 204) and then drop the spli brass bearing (Fig. 205) into place in the clip.

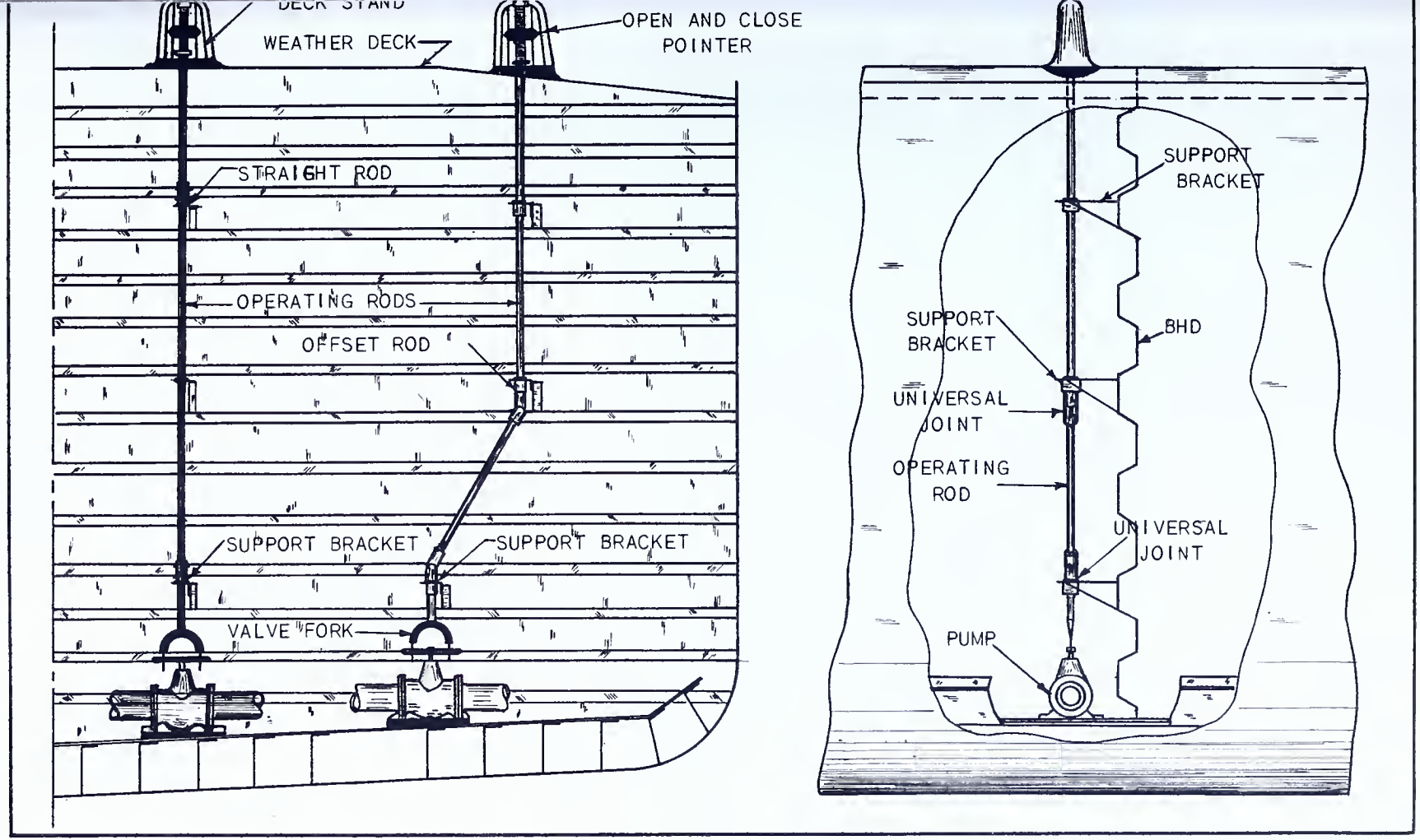


Fig. 200--Typical Installation of Operating Rods

TOOLS AND EQUIPMENT

1. Portable air drill
2. Open end or adjustable wrench 1/4 to 1" U.S.S.
3. Taper reamer for #6 taper pin
4. Drill for #6 taper pin (See Chart)
5. Six-foot steel tape
6. Fifty-foot steel tape
7. Chalk line
8. Center punch
9. Machinists' hammer
10. 10-inch dividers
11. Punches and wedges
12. Pliers
13. Level
14. Declivity board
15. Calipers
16. 6" scale
17. Hack saw
18. Stillson wrench
19. Plumb bob

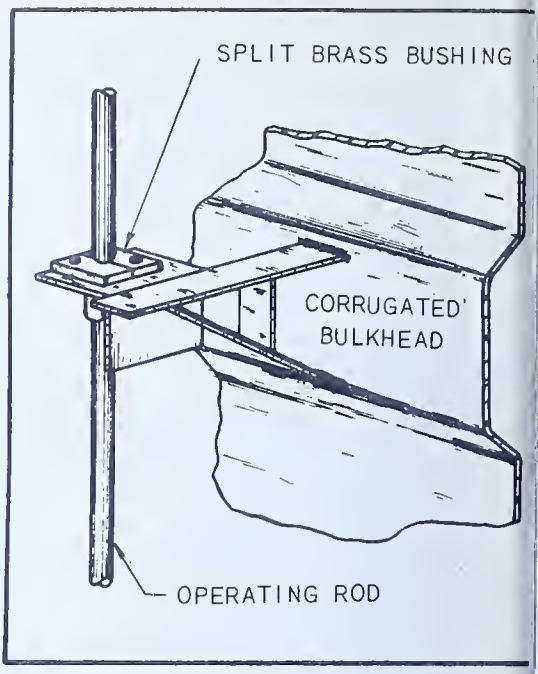


Fig. 203--Details of Operati Rod and Bracket

SUPPLIES

1. Soapstone pencil
2. Blue or white chalk

PROCEDURE

1. Hang rods on deck sta and connect with valve
2. Pin and bolt rods toge through sleeves or uni sals.

NOTE: If straight rods used, no univer are necessary. versals and coupl are placed as c

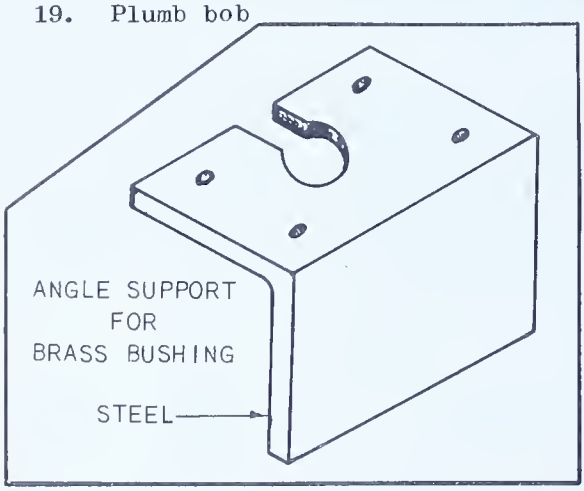


Fig. 204--Slotted Angle Clip

as possible to the bearing bracket and bearing to support the rod and prevent "whip".

3. Install brass bearings and line up. See Fig. 201.
4. Have brackets welded to corrugated bulkhead. See Fig. 203.
5. Check line-up of bearings and tack bearing angle-clip to brackets. Operating rod must turn freely.

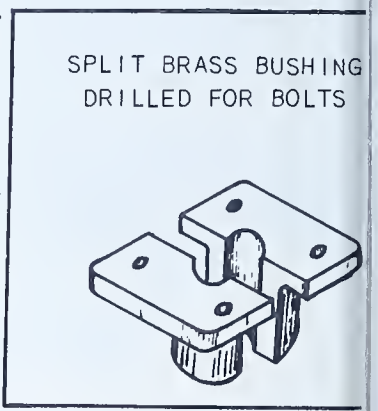


Fig. 205--Lignum Vitae or I

6. Have angle-clip and bracket support welded when the operating rod turns freely.
7. Inspect all bearings and brackets to be sure the joints are free. Check with the leader.
8. Install indicator slide on deck-stand screw and mark-deck stand for OPEN and CLOSED positions. The instructor will explain how to do this.

Fig. 206--Operating Rods Installed Correctly

UESTIONS

1. For what purpose are operating rods used?
2. Why are some operating rods fitted with universal joints?
3. At what point in the installation are the bracket supports welded to the bulkhead?
4. What is the purpose of the stepped ends on operating rods?
5. State the type pin used in the couplings and explain how these pins are installed.
6. What supports the operating rods up and down?
7. When are the indicator slides installed?
8. Explain the purpose of the indicator slides?

Fitting A Sea Chest Strainer Plate

INFORMATION

The purpose of a condenser is to reduce to water the live steam exhausted by the turbine or engine before returning it to the boiler. Cool sea water is sucked into a pipe line which is connected to a water jacket or manifold at one end of the condenser; it is then pumped through the tubes of the condenser and overside back into the sea.

PURPOSE OF A STRAINER PLATE

The sea water, mentioned above, enters a sea chest, which is a steel casting or a box-like fabrication of boiler plates. See Fig. 207. The position of the sea chest is under water.

Unless some provision is made to guard the end of the suction pipe, all sorts of foreign matter, such as seaweed, ice, wreckage and so on, would fill up the sea chest and pipe and plug up the space

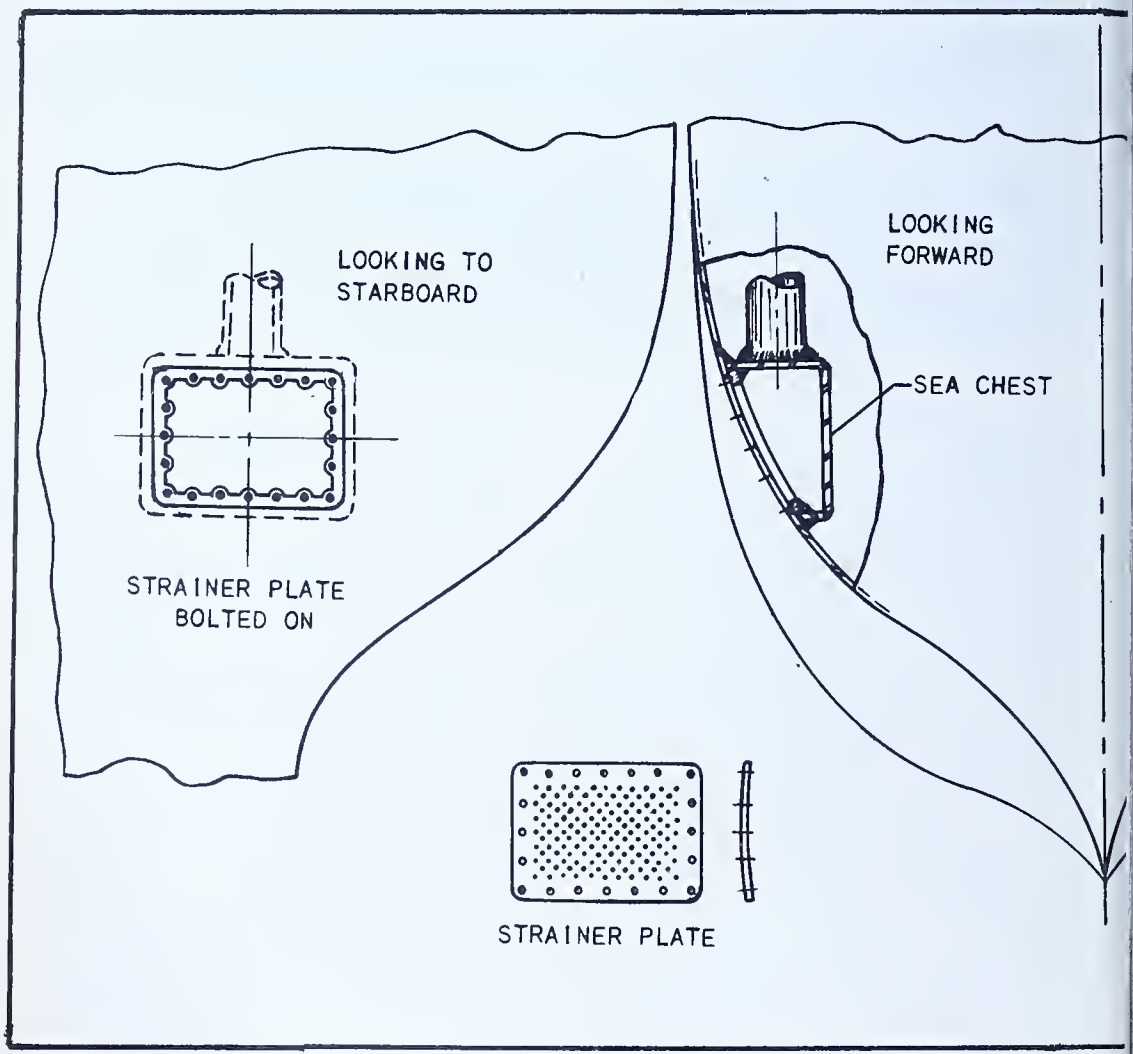


Fig. 207--Details of Sea Chest Strainer Plate

the condenser water jacket. To prevent anything like this from ppening a strainer plate is fitted over the opening in the sea chest, en with the shell of the ship. See Fig. 208.

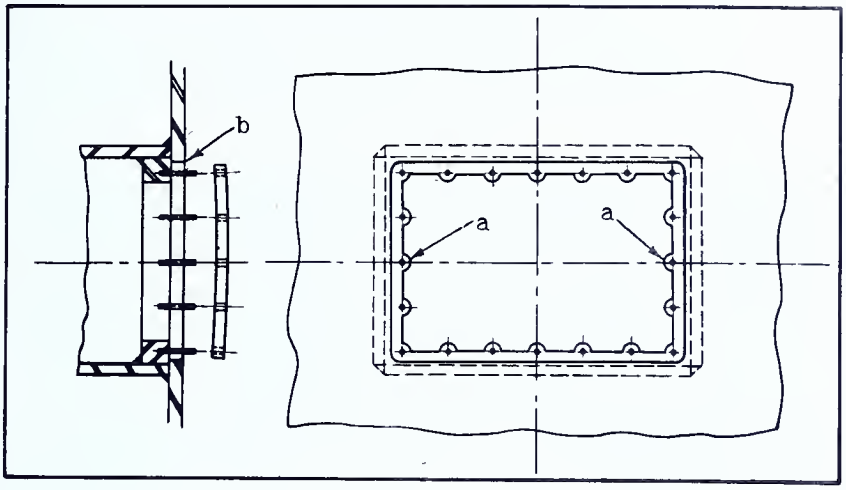


Fig. 208--Strainer Plate Ready for Fitting

STALLING A STRAINER PLATE

NERAL PROCEDURE

1. Locate the correct strainer plate for the sea chest. (Part No. of strainer plate is usually found on the sea chest blueprint).
2. Place strainer plate in position on sea chest and check to see if the joint fits well. About 1/8" is allowed all around the edges. See Fig. 208 at "b".

   NOTE: The strainer plate is hoisted into position by means of a crane and helpers assist in holding the strainer plate, in position while it is being checked for a fit. If the fit is not correct, the plate will have to be swung out and the high spots removed. Some strainer plates are made of cast iron and have square strainer holes cast in, while others may be steel with the strainer holes drilled. Chip or grind the high spots until the fit is satisfactory.
3. With the strainer plate held tightly in place, scribe through the holes which are in the edges of the plate. (This marks the location of the studs which are to hold the strainer plate in position. Some mechanics prefer to begin at the two center studs "a-a" Fig. 208 and work toward the edges.
4. Center the locations of the stud holes and drill for tapping. Check with the leader for the correct size of drill.
5. Tap the holes.
6. Install the studs.
7. Try the strainer plate on the studs to check the fit.

8. Check with the leader at this point for inspection.

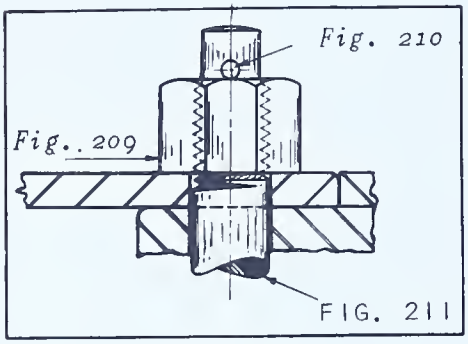
NOTE: All the joints in the sea chest and between the s chest and the hull must be inspected to make sure the are no leaks.

The inside of the sea chest must be painted a the bottom cemented to prevent rusting when the ship "riding light". The blueprint indicates where ceme and paint are needed. When the inspector has given l approval proceed.

9. Put strainer plate on over the studs and draw nuts up secure

10. Install split pins or cotters in drilled holes through studs SPREAD THE ENDS OF THE SPLIT PINS.

NOTE: The nuts used on this job are brass; the studs are sta less steel; the split pins are brass. See Figs. 209, 2 and 211.



-Stud Assembly

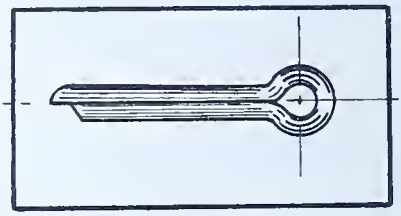


Fig. 210--Split Pin

QUESTIONS

1. Explain the purpose of a strainer plate.
2. State how the strainer plate is fastened to the sea chest.
3. How much clearance is allowed between the edges of the strainer plate and the sea chest opening?
4. Why do some mechanics prefer to begin at the center studs and work to the edges when marking the position of the studs?
5. Outline the procedure followed when fastening the strainer plate to the sea chest.

Installing Main Suction Valve

INFORMATION

A main suction valve is usually located on the port side of the engine room; it is generally below floor plates and secured to the sea chest with studs or, in some cases, with through bolts in a flange. Its purpose is to supply water from the sea to the main circulating pump. See Fig. 212.

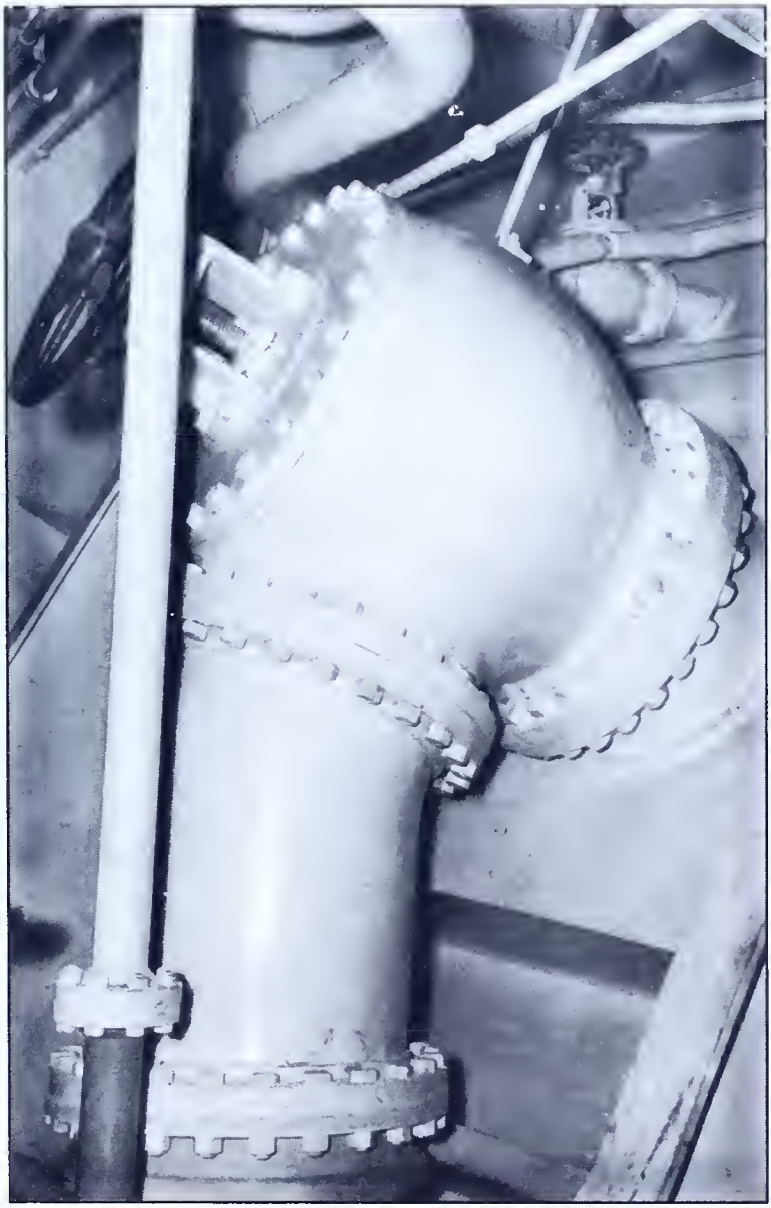


Fig. 212—A Main Suction Valve Installed

TRYING THE VALVE FOR FIT

Some valves are bolted to the overboard spools with bolts and nuts. Other valves are set over studs that are securely screwed into the mating flange. The valve flange is provided with holes which are expected

to fit over the studs in the mating flange. Difficulty is experienced when the holes in the flanges do not match. See Fig. 213.

There may be so little difference at some points that it may be possible to bend the stud slightly with a blow of the hammer. When the studs, or the mating holes, are too far out of line for the studs to be adjusted with a hammer, file or ream the tight hole or holes until a fit is obtained.

TEMPORARY VALVE SUPPORT

Because the valve is heavy, it is supported by chain falls until the final moment comes to set it and tighten it in place. Always make sure the gaskets, studs, or bolts, fit correctly before attempting finally to tighten the nuts which hold the valve in place.

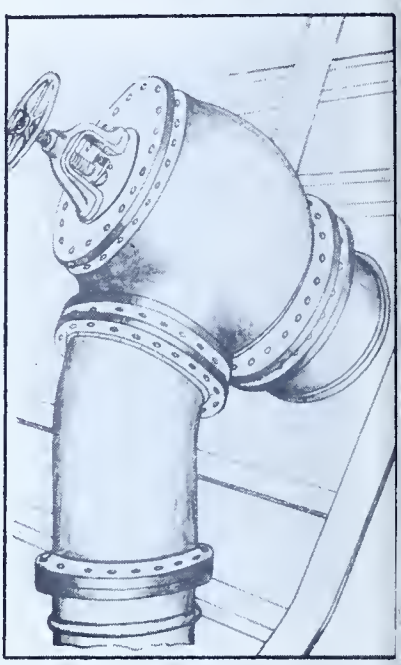


Fig. 213—Fitting the Flanges

TOOLS AND EQUIPMENT

1/2-ton chain fall
Regular tools

MATERIALS

12" suction valve
12 1-1/8" x 4-1/2" stud bolts
12 1-1/8" boiler washers
12 1-1/8" hex nuts
1/8" x 18" x 18" wire inserted sheet rubber (1 piece).

GENERAL PROCEDURE

1. Screw one stud in stud hole by hand until tight.
2. Using 1/2-ton chain fall conveniently placed, set the valve over the stud and try to insert the balance of the studs to make sure they are fair (that is, fit the holes in the valve flange.) If the studs do not fit in the holes after being screwed in place. knock them one way or the other until the valve flange fits flush against the sea chest. In case a stud is out of line too much to be knocked into place, it will be necessary either to ream or file the valve flange hole to match.
3. Remove the valve from the studs and thoroughly clean the faces of the valve and the sea chest flanges.
4. Cut out the wire inserted rubber gasket to fit the valve flange.
5. Place the gasket over the studs and smooth out flat on the chest flange. Never use lubricant of any kind on a rubber gasket.
6. Using a 1/2-ton chain fall, place the valve over the studs. Lower the valve until the valve flange is flush against the gasket.

7. Place a special washer over each stud. A standard washer may be used if there is enough room.
8. Put nuts on each stud and pull down hand-tight to make sure that the flange fits square all around.
9. Using open end wrench, tighten the nuts, going around evenly two or three times.

QUESTION S

1. How does the mechanic check the "fit" of the holes in the valve flange with the mating holes in an adjacent connection?
2. If there are holes which do not line up, what is the procedure?
3. Is it possible to make a stud line up with a hole in the flange if it is only a little out of line? How?
4. What type of reamer is used to "line up" two holes?
5. Why are the flange faces thoroughly cleaned before installing a gasket?
6. Explain how the nuts should be pulled up to insure a watertight joint and an equal tension on all studs.

Installing Overboard Spools

URPOSE OF OVERBOARD SPOOLS

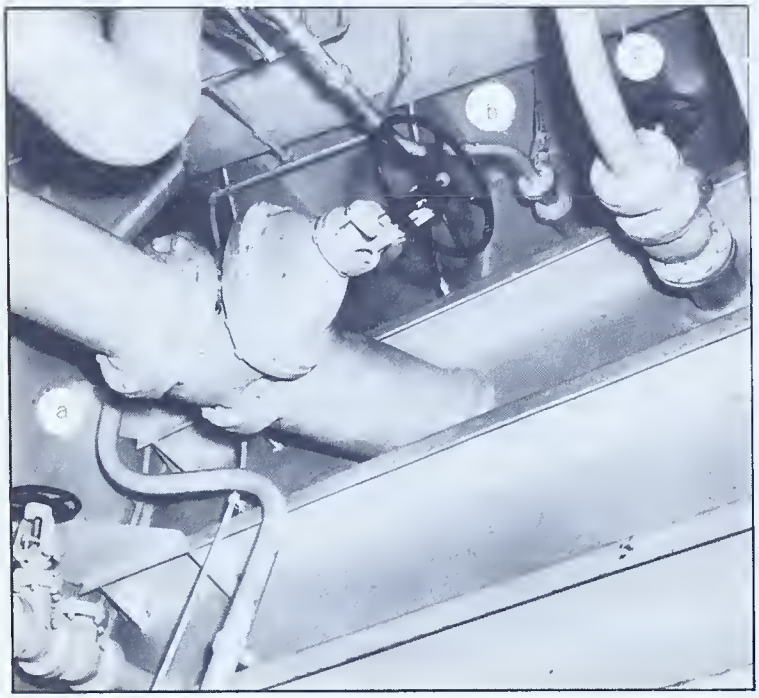
The purpose of an overboard spool is to make the connection from he shell of the ship to the pipe line which runs from the main conenser. There is a circulating pump in the pipe line which pumps the ea water from the high or the low sea chest, depending on which one s in use.

When the ship is low in the water, or when the ship is in shallow ater, the lower sea chest suction valve is closed to prevent ice, mud, r debris of various kinds from getting into the line. There is a blow own steel pipe connected to the sea chest for the purpose of cleaning ut any accumulation of debris that may get in from time to time.

The sea water is drawn in by a suction pump and circulated through he condenser tube to condense the steam from the main engine. The ater is then discharged through the main condenser line overboard spool t a higher temperature.

REVENTION OF LOOSENING BY VIBRATION

All joints must be perfectly tight, and the spool must be secured in lace firmly, so that there is no chance of the installation's becoming oosened by vibration. The connecting pipe line from the overboard spool o the condenser is copper tubing about 24" in diameter, and there is a lexible joint in the line to take care of expansion, contraction, and ibration. See Fig. 214.



Four overboard spools of various sizes are shown in Fig. 214. Note the copper tubing shown at "a"-"b"-"c".

Fig. 214--Typical Overboard Spool Installations

SIZES OF OVERBOARD SPOOLS

Overboard spools are usually steel castings, weighing up to as much as six hundred pounds. When handling these jobs, play safe. Be sure to keep clear at all times and avoid injury while the riggers are lifting the spool into place with the crane or chain fall.

There are in use other types of overboard spools from which waste water is discharged. These spools of different sizes and are set at different angles according to the blueprint. Each type of ship has different requirements.

SOME LOCATIONS OF OVERBOARD SPOOLS

Overboard spools are installed for various purposes as follows:

Bilge overboard discharge.
Cooling water from main condenser overboard discharge.
Cooling water from auxiliary condenser overboard discharge.
Sanitary system overboard discharge.
Ice machine cooling water overboard discharge.
Boiler blow down valve discharge.
Lubrication oil cooler overboard discharge.

LOCATING THE SPOOL

Before the spool can be installed, it is necessary to mark the position of the opening which receives the spigot end. This opening is laid out on the inside of the shell of the ship.

OLS AND EQUIPMENT

1. Combination square with protractor.
2. A chalk line
3. Declivity board
4. Trammels
5. Hammer
6. Center punch
7. 6' tape

TERIALS

Chalk
Blueprint

OCEDURE

1. Check the blueprint for the correct frame number near which the opening is to be located.
2. Check the blueprint for correct longitudinal height of the opening in the shell.

   NOTE: It is very important to identify the correct longitudinal and frame when checking the blueprint for the location of the center of the spool opening.

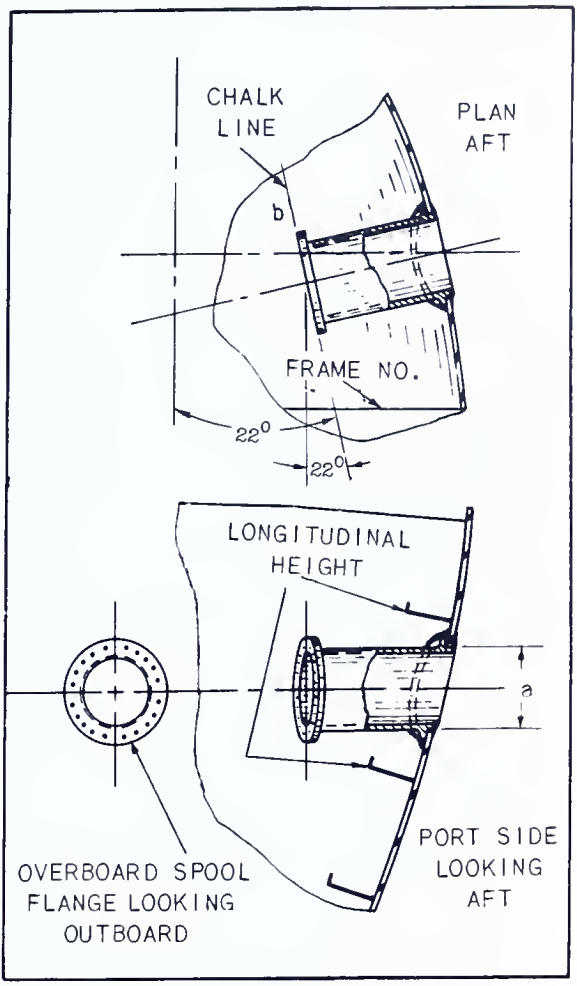


Fig. 215--Locating an Overboard Spool

3. Mark the center of the spool opening with a center punch.
4. Find the diameter of the spigot of the spool, See. Fig. 215 at "a".
5. Set trammels to 1/8" more than the radius of the spigot diameter.
6. Set one leg of the trammel in the center punch mark, and scribe the circle on the shell of the ship.
7. Make center punch marks all around the circle about 2" apart. Check with the leader for his approval up to this point.

   NOTE: The shell of the ship is burned out with a torch to the circle. The center punch marks act as a guide and check on the accuracy of the burning.

8. Have the shell burned out to the circle. (This is a job for the burners.)

9. Have a ship rigger lift the spool into place, with the spi end in the hole which has been burned out to receive it.

10. Stretch the chalk line from the flange face of the spool to nearest frame. See Fig. 215 at "b". The chalk line must l up at an angle of 22° with the frame.

11. Rotate the spool to bring the flange face parallel with chalk line. (22° with the frame.)

12. Check the holes in the flange with the declivity board. Fig. 216.

    NOTE: This is done by placing two bolts through the fla holes which check nearest to the declivity board ang Place the wide end of the declivity board aft and le the top of the board while resting across these bolts. See Fig. 216.

13. Plumb the vertical way of the flange, using the combinati square and the head stock level.

14. Check the shoulder of the spigot; make sure it is tight agai the inside surface of the shell of the ship.

15. Tack weld all four points, top, bottom, fore and aft.

16. Check again for the position. If it is approved by the lead proceed to weld all around the spigot and shell.

17. Order the bolts which will be used to fasten the discha valve to the flange end of the overboard spool.

    NOTE: The length of these bolts must be measured so that the nuts are tightened down the ends will not be m than 1/16" below the face of the nut or project more 1 1/4" beyond. The thickness of the overboard sp flange, the thickness of the discharge valve flange, the thickness of the nut must be carefully measure get the correct length of the bolt.

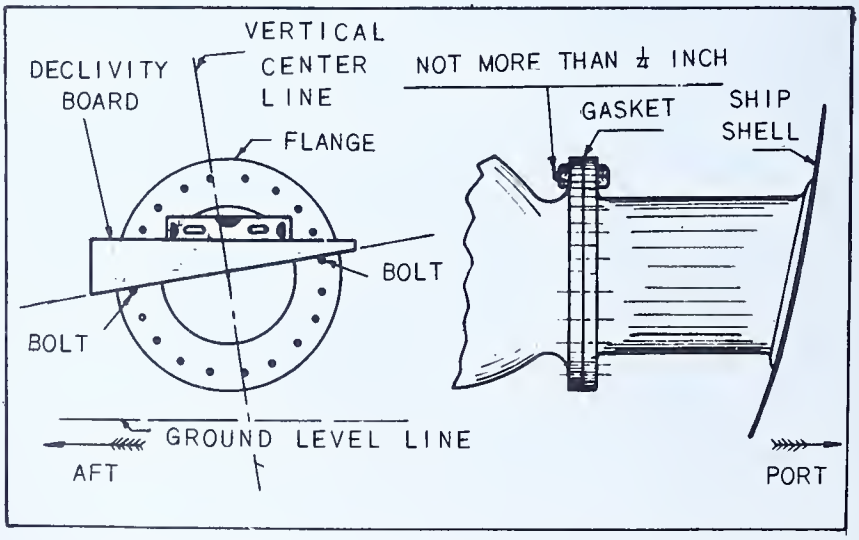


Fig. 216--Checking the Position of the Overboard Spool

18. Have the riggers raise the discharge valve into position and bolt fast. Make sure to pull every nut down tightly. Check with the leader.

19. Bolt the overboard discharge valve to the flange end of overboard spool. Use 1/8" rubber gasket between flanges.

STIONS

1. What is the first step in locating the position of an overboard spool?
2. How is this location for the overboard spool laid out on the ship shell?
3. Explain the method used to cut the hole in the ship shell for the spigot end of the overboard spool.
4. What is the procedure for checking the angle of the overboard spool flange with the frame of the ship?
5. How is the declivity board used when setting an overboard spool in the correct position?
6. When is the spigot end of the overboard spool welded to the shell of the ship?
7. State how the correct allowance for the nuts is determined when ordering bolts to secure the valve flange to the overboard spool.
8. How thick is the gasket material between the overboard spool flange and the valve flange?

PART III

OUTSIDE MACHINIST TRAINING
INSTALLATIONS, MAINTENANCE, REPAIRS

PART III

Running a Tight Line

RPOSE OF A TIGHT LINE

A tight line is used to locate the center line of the line shaft. Te line shaft is connected to the propeller at the stern and ends in te engine room, an over-all distance of about 70 feet. This line saft, see Fig. 218, is made up of four lengths, coupled together to frm one continuous length and supported by bearings which are held se-crely on foundations placed at suitable intervals. The foundations fr the bearings must be secured to the tank top of the double bottom. Se Ship Terms and Locations, Part I.

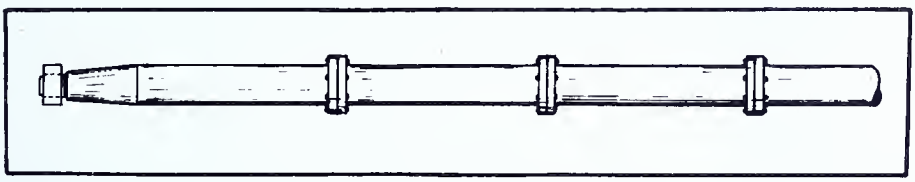


Fig. 218--Line Shaft

ERN FRAME

The stern frame is a steel casting which has been welded to the ern plates of the hull, thus becoming a solid part of the ship. See g. 219. The opening "a" is cast in the stern frame, and it is through is opening or "eye" that the line shaft turns and thus turns the pro-ller.

The eye must be bored out, d the center of the bored le must be exactly in line th the center line of the el and the correct height ve the tank top, mentioned the first paragraph of this struction sheet. Check on ls height with the leader.

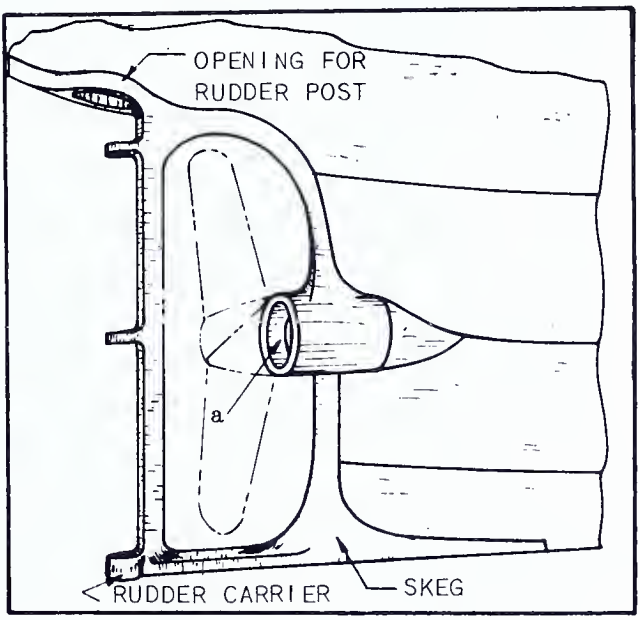


Fig. 219—Stern Frame in Place

SITION OF LINE SHAFT

In the engine room, the nter of the line may be 3' 1/4" above the engine bed. ls varies according to the pe of ship.

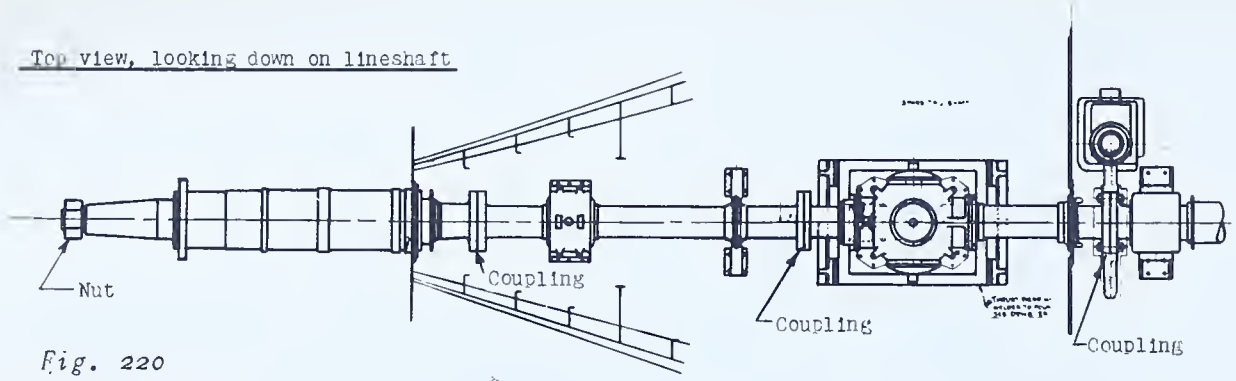
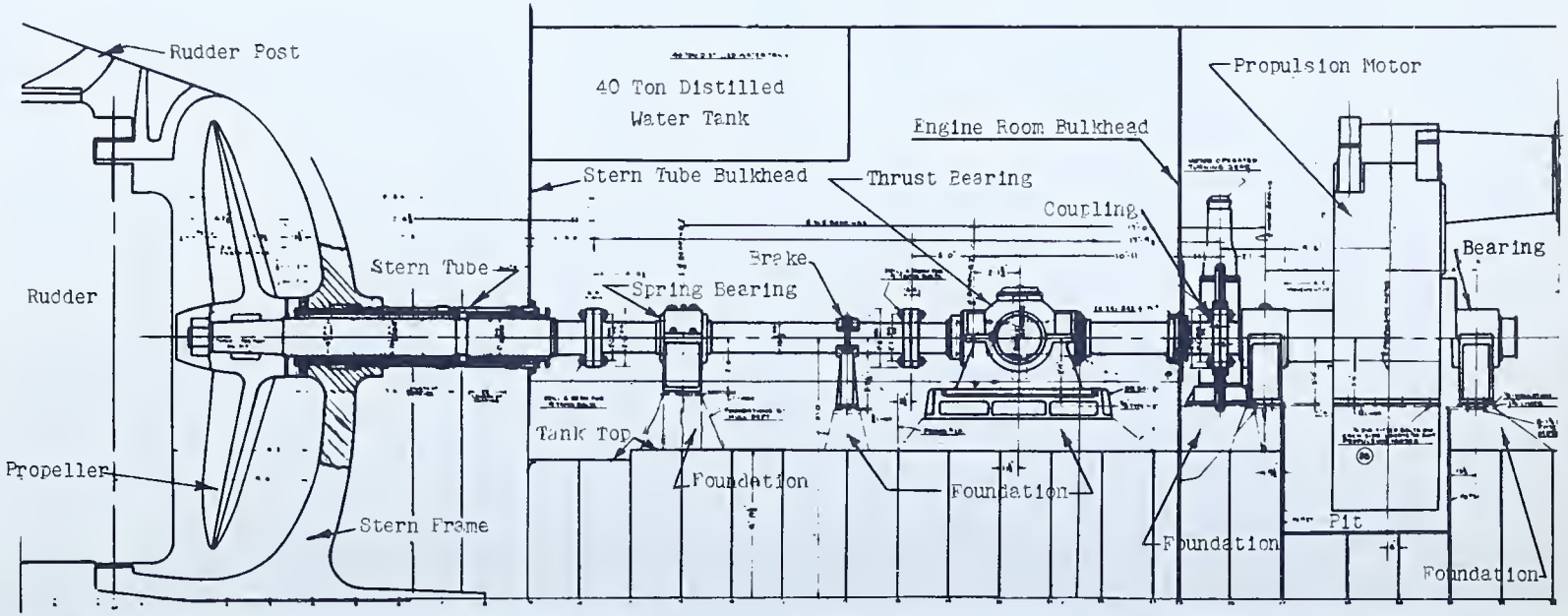


Fig. 220
Line Shaft Assembly



e center of the line shaft may be 3'-8-1/4" above the thrust bearing undation. This also varies. Enough stock has been left in the stern ame eye to allow for boring out. The engine foundation has been in- alled in the correct relationship with the center line of the ship. ere is a center line marked off on the bulkheads and deck plates of e ship. The stern frame has been lined up with this center line and lded in place.

NTER OF LINE SHAFT

All that now remains to be done is to establish a center line above e deck plates and in line with the ship center line. This is the pur- se of a tight line. From this tight line, measurements are taken to cate the spring bearing, the thrust bearing, the supports for the pro- lsion motor, the circle for the holes in the three bulkheads (see note) t of the propulsion motor, the stuffing box and the line shaft in the gine-room watertight bulkhead, and the circle for the bored hole in e eye of the stern tube. See Fig. 220.

NOTE: Some ships have more or less than three bulkheads at this location, depending on the type of ship. The operation of boring, however, remains the same in principle.

GHT LINE

The tight line used on this job is a piano wire, .018 of an inch in ameter. The same size of wire and the same tension are employed each me a "tight line" is run. On oil tankers, the length of the line is out 70 feet from one end support to the other. On other types of ips this distance will vary. Figure 221 shows these two supports: "horse" on the outer face of the "eye" and a "line target" at the her end of the line, in the engine room. See "a" and "d".

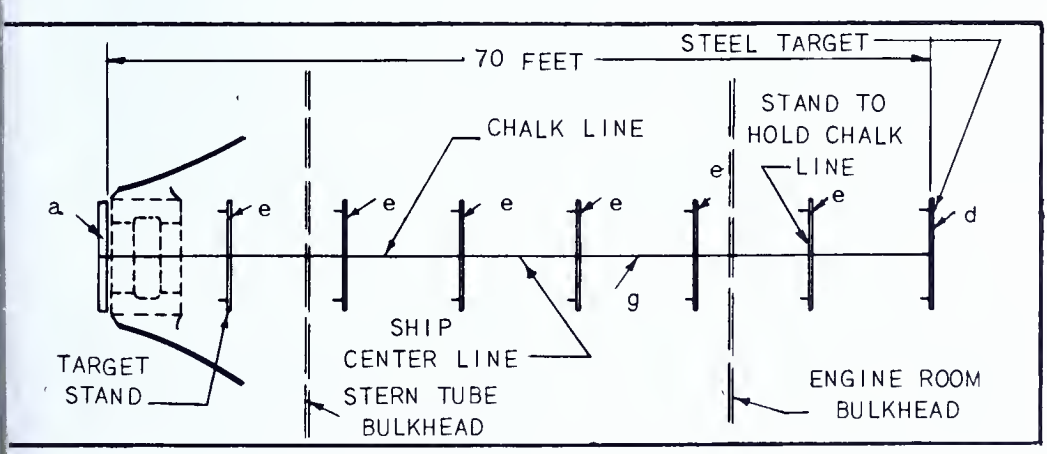


Fig. 221—Target Stands Set to Center Line of the Ship

TTING THE TARGET STANDS OR SUPPORTS

The target is a centering device, or metal bar, which is bolted ross the two columns of an angle iron support that may be bolted or ck welded to the deck plates or tank top. See Fig. 222. In order to

set the target in the corrrct position, a chalk line is stretched fr the engine room to the outer face of the eye at the stern, and by mea of a plumb bob and line the chalk line is located exactly above the ce ter line of the ship. See Fig. 221.

NOTE: The center line of the ship was located by the shipfitters all along the tank top and on bulkheads with center punch marks as the ship was being built. The outside machinist follows all such center lines when laying out his work.

Figure 221 is a view looking down on the entire line shaft location as in the top view, Fig. 220. A "horse" "a" is placed across the stern-frame eye. A target stand (See Fig. 222) is set in position as at "d". The chalk line "g" is adjusted until its position is directly over the ship center line which was center punched on the deck by the shipfitters. A plumb bob and line are used to determine the correct position of the chalk line.

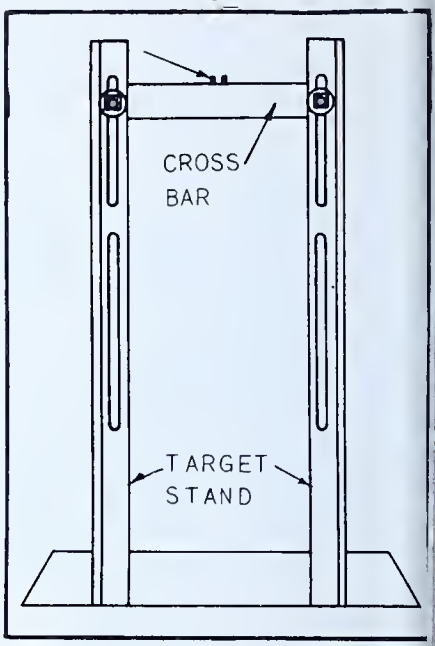


Fig. 222—Target Stand Assem

The distance from "a" to "d" is about 70 feet, and a target sta is set up, as at "e", every ten feet. The chalk line gives the loc tion for the center of the target stand and the height of the targ stand crossbar. When all the targets have been placed, the crossba are adjusted so that they just about touch the chalk line on the und side. When doing this, make sure the chalk line is stretched TIGHTI

NOTE: All target stands are not of exactly the same constructio but they all serve the same purpose. When the tight li has been run and the necessary points located from the li the target stands are stored away for the next job. Alw store the target stands carefully, together with all bol nuts, and crossbars, so that no time may be lost in look for this equipment the next time it is to be used.

PLACING THE TIGHT LINE

The chalk line is now removed entirely. It has served its purpo The support "a" is relocated for holding the tight line. See Fig. 2 Two brackets, "k", are tack welded in place temporarily. These brack support two stools "l". "a" is now supported by the stools. The sto and the bar are bolted to the brackets and may be adjusted to bring tight line into alignment with the ship center line.

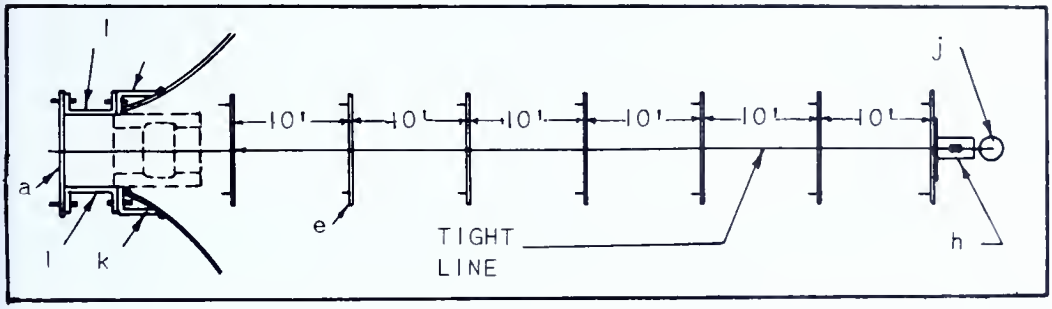


Fig. 223--Cross Bars Centered to Hold Tight Line

The reel and supporting bracket, "h", are bolted to the target cross-ar in the engine room. See Fig. 224. Check the reel to see that it is ell oiled and running free. Check the stop screws on the reel to make ure that the reel is locked n all positions before loca-ing any tram marks. The tight ine is unwound carefully and arried back through the sev-ral openings in the engine-oom bulkhead: the stern-tube ulkhead, the bulkheads between ne stern frame and the stern-ube bulkhead, and finally hrough the eye of the stern rame where the end of the tight ine is securely fastened to the rossbar "a". Figure 224 shows hat the reel is notched in four r more places. The weight "j" s hung from one of these otches.

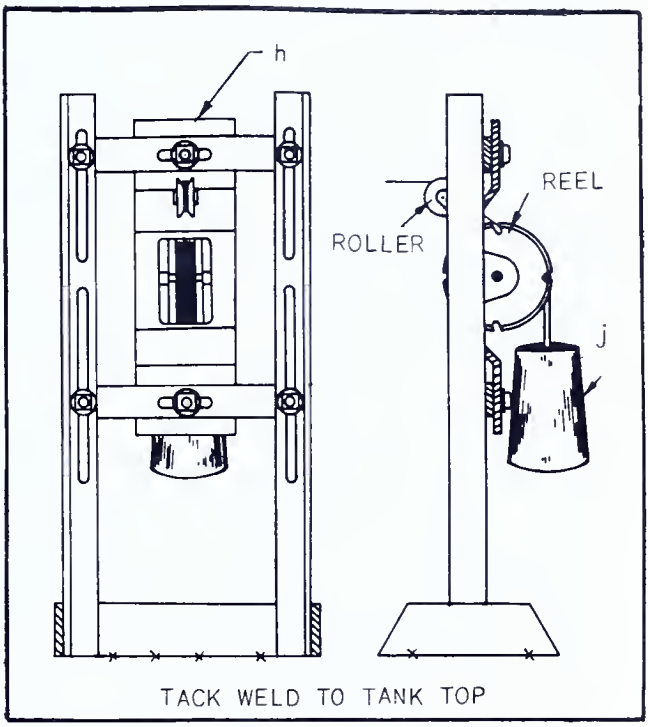


Fig. 224--Tension Weight and Reel

ENSION ADJUSTMENT

The piano wire used as a ight line is .018 of an inch n diameter. When this size f wire is supported at two laces, 70 feet apart, and stretched with a certain tension, the "sag" f the wire will form a long, gentle curve. This curve is always the ame if the wire is supported, as above, and tightened the same amount ach time.

A 27-3/4 pound weight is used to keep the wire in tension when the ver-all distance is 70 feet. See "j", Fig. 224. The amount of sag has een figured very carefully. It is definitely known that a tight line lways sags a certain fixed amount, according to the size and length of he line. See illustration, Fig. 225.

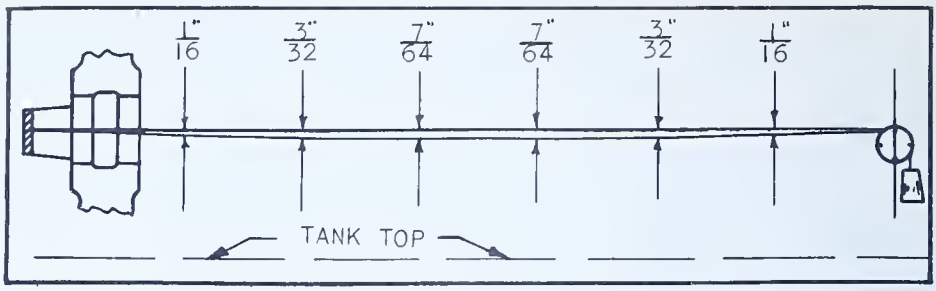


Fig. 225--Showing the Sag in a Tight Line

SAG BLOCKS

Inasmuch as it is definitely known how much a tight line sags ten feet, it is only necessary to raise the wire that much to make t line level. Figure 225 gives the correct amount at every ten fee Figure 223 shows two small pins in the target or crossbar which bolted to the target stand. These pins are there to hold the s blocks in place and to guide the tight line along the center of t target stands. Figure 226 is an illustration of a sag block locat in place over the two pins in the crossbar. Sag blocks of the sa thickness as mentioned in connection with Fig. 225 are used as long the distance between tight-line supports remains 70 feet. If this di tance changes, sag blocks of a different thickness must be used.

ADJUSTING THE CROSSBAR

With the tight line in tension, the end supports are carefully adjusted to bring the wire directly over the ship center line as was done with the chalk line. *This adjustment must be exact.* A plumb bob and line are used as before. The height of the tight line at the engine-room-target end must be according to the blueprint. This height is usually 5' 2" from the engine room tank top to the under side of tight line. Check and recheck the height of the line to provide fo chock thickness of 1-1/2" under all of the bases of the units being stalled. Check with the leader.

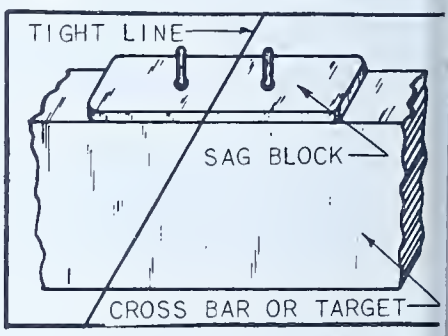


Fig. 226--Sag Block Pins

The crossbars must now be raised and adjusted until a light sh the bar barely touching the wire. Tighten the crossbar bolts and ch with the leader. When all the crossbars have been adjusted, place sag blocks on the pins and recheck at every point to make sure the adju ment is correct for height and center location. Remember the tight l is the center of the line shaft. Measure carefully, tighten all adju ing bolts, and check with the leader.

LOCATING MACHINING POINTS

Before any machining, such as boring and facing, can be permitt the tight line must be removed. Certain measurements have to be ta from the tight line, and markings made. Figure 227 shows the ou

ɔe of the stern-frame eye. The center the tight line is plainly marked. Four ıter punch marks must be made as shown points "c".

The distance of the center punch marks ɔm the center of the tight line should be ɔut one-half inch greater than the radius the bore in the stern-frame eye. The ason for this is that after the eye is ·ed a check may be made from these gister" or tram marks and the accuracy the work thus assured. A cold chisel is d to mark a small square around the tram ·ks so that they may be easily located.

Similar measurements and center punch ·ks are made at every opening through ch the line shaft will pass. It should quite clear that if the tight line is ı correctly and if the tram marks are ated accurately, the finished job will satisfactory. The slightest error ns serious trouble later.

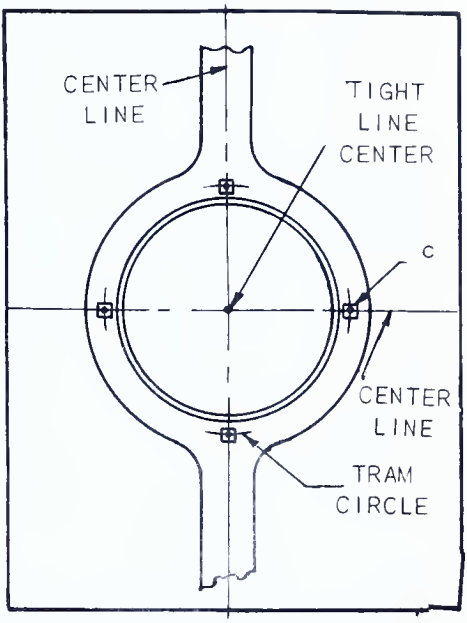


Fig. 227--Tram Marks on Stern Frame Eye

When taking a measurement from a tight line to a tram mark, "snap" line to make sure it is on center. Unless this is done there is ger that the line may be slightly to one side. Check this repeatedly.

NOTE CAREFULLY:

When measuring from a tight line with the tight line itself as a center to a point 10" from that center, be sure to subtract half the diameter of the tight line from the 10".

The diameter of the tight line is .018".
The radius of the circle is 10".
The measurement from the side of the tight line to one edge of the diameter of the circle would be 10-.009, or 9.991 inches.

For any measurements from a tight line set the micrometers to allow half the diameter of the tight line.

STIONS

1. How much does a tight line 70 feet long and .018" in diameter sag in the center if unsupported?
2. If the tight line is not located directly over the ship center line, how will this affect the alignment of the line shaft?
3. State the precaution which should be taken when locating tram marks with a center punch.
4. How does the mechanic make certain that the tight line is "on center" when taking measurements?

5. What device is used to hold the tight line at the proper tension?
6. What is the correct distance from one target support to the next?
7. Why is a chalk line run before setting the target supports?
8. Explain the reason for burning a hole larger than the stern tube in some bulkheads.
9. How does the diameter of the tight line affect a measurement taken from the center of the tight line to the circumference of any circle scribed about the tight line as the center?

* Removing A Tight Line

INFORMATION

The piano wire used for locating the shaft center line is compa tively expensive, and the slightest abuse can render it useless for f ther service. The *time* required to prepare another line would have be added to its cost in case a second tight line had to be used. I tight line is kinked, it is of no further use as a tight line.

MATERIALS

Tight line ready for remo

PROCEDURE

1. Unfasten the after end of the tight line from the adjusta bracket.
2. Have one helper hold loose end of line and carry it toward reel which winds up the line at the other end.
3. Have a second helper apply oil to the line with a rag.
4. Turn the reel crank, and wind the line on the reel neatly ur all the wire is wound.
5. Secure the loose end by inserting it under two or three str of line and then pulling it up tight.
6. Wrap an oiled rag around the line on the reel and place reel of line in the reel box.
7. When you have finished with the line and the reel, see t they are returned to the tool room.

QUESTIONS

1. Why must care be used in removing the tight line from the shaft center line location?
2. Three men are used in removing the line. What does each man do?
3. What precaution is taken before placing the reel of line in the box?

*Adapted from "Outside Machinist", Alabama State Department of Educat

Setting A Portable Boring Bar

FORMATION

The illustration at the right, Fig. 228, shows a heavy steel cast-g, the stern frame, which is welded solid with the stern plates of a ip's hull. The hole in the hub is the stern-tube housing and is called e "eye" by shipyard mechanics.

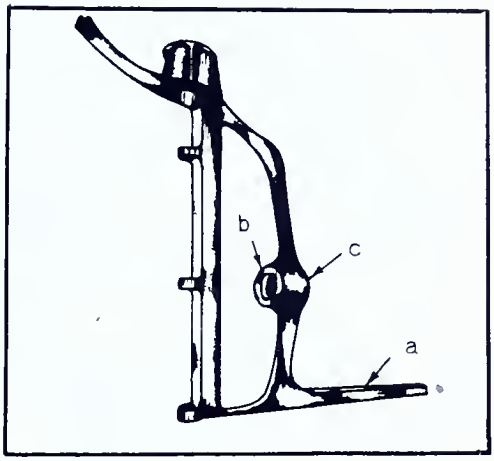


Fig. 228--Stern Frame

The lower portion "a" is called e SKEG. The surface "b" is called e outer face of the eye and "c" is lled the inner face of the eye. e stern-tube housing must be bored t to a certain size to fit the stern be. See appendix for definition of ern tube.

Figure 220 shows a longitudinal oss section of a ship's hull in the ttom view. Note carefully the loca-ons of the bulkheads, bearings, stools, d couplings. The stools which sup-rt the shaft bearings are welded to e tank top before the tight line has en run. When the construction is complete, the center line of the ne shaft must occupy the same position as the tight line occupied fore it was removed.

While the tight line was in position, tram marks were accurately cated on the outer face of the eye (Fig. 227) and around the rough e in the stern-tube bulkhead (Fib. 220). Tram marks were located the engine-room watertight bulkhead and on the two bulkheads imme-tely forward of the stern frame.

The diameter of the portable boring bar is 5" to 14". A heavy is always used on large work. Always use as heavy a bar as possi-e to avoid spring. See Fig. 229. The diameter of the eye will sily accommodate the boring bar. Other holes in the bulkheads have en burned out small enough for finish-machining and at the right ation with the center line.

The eye in the stern frame is to be bored 30".

The hole in the first bulkhead forward of the eye is to be bored .

The hole in the second bulkhead forward of the eye is to be burned 32-3/4" to allow the stern tube to pass freely, but it is not bored. there are other bulkheads at this location, the blueprint will show ch ones are to be bored and which are to be burned.

The hole in the engine-room bulkhead is bored 32-3/4" less about 3 of one inch. The .003 of an inch is to allow for a press fit when ling in the stern tube.

Study Fig. 229 carefully. The fittings on the main boring bar may be removed, leaving a bare bar. The entire assembly may be moved kward or forward and secured in any desired location.

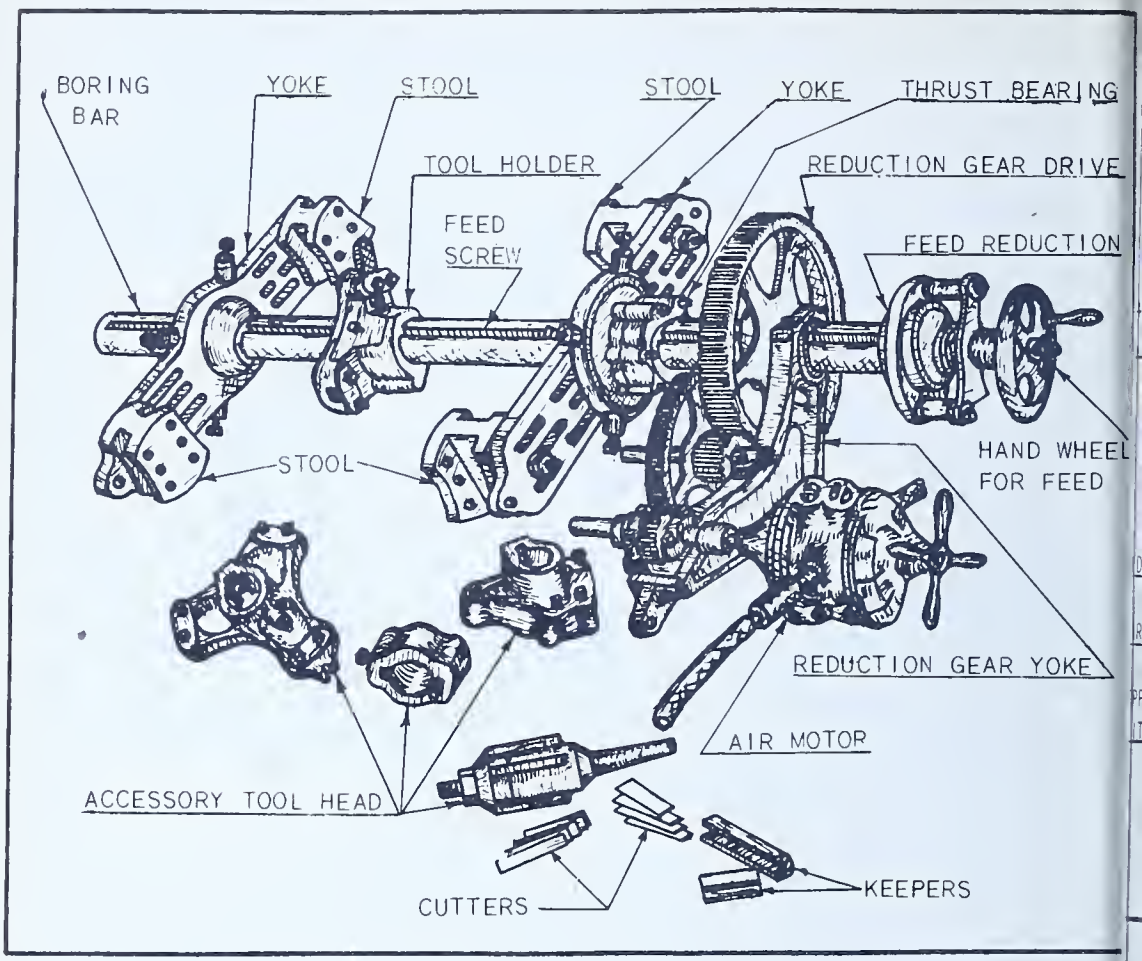


Fig. 229--A Portable Boring Bar Assembly

Four stools, Fig. 229, swivel on the yokes and have several bolt holes allow the yokes to be secured to a support as conditions require.

The yoke on the end opposite to the hand-feed wheel may be remov and the bar slipped into the after end through the hole in the stern-fra eye if the ship has twin propellers. Other parts of the portable bori bar have to be removed while preparing to set the bar in a tight pla where one propeller is used. In this case it is lowered into the aft peak and run through the eye from the inside.

The boring bar is slung in a chain fall and passed through the e where a second chain fall is ready to receive it. The bar is locat by raising or lowering the chain fall; it is braced sidewise as near the center of the layout as possible by rough measuring. The yokes a adjusted to a convenient position, and supports to which the boring-b yokes may be securely bolted are welded to the deck plates and bulkhea See Fig. 230. These supports are sometimes called "spiders".

After the boring bar is secured to the spiders it may be adjust to a location exactly central with the tram marks which were locat from the tight line.

As the main bar of the boring bar assembly is straight and true, measurements that may be taken from the outside diameter of the bar wi

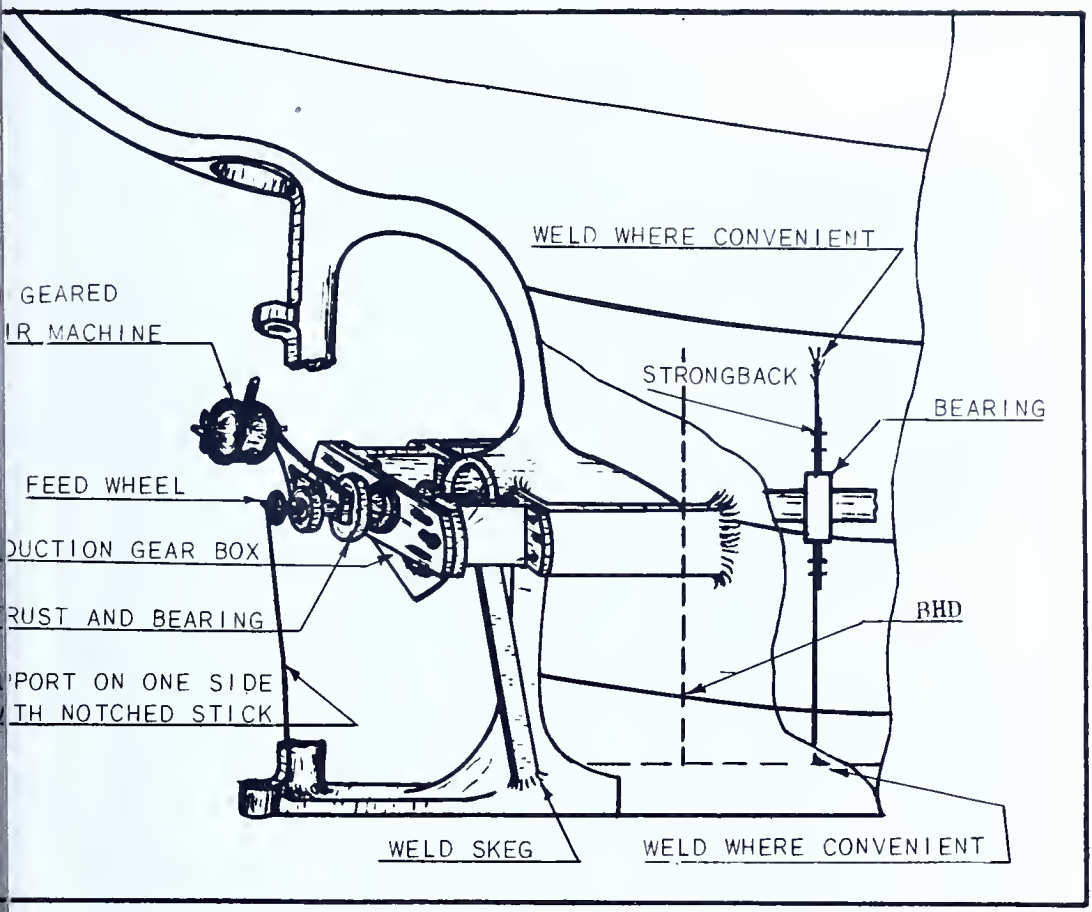


Fig. 230--Boring Bar Supports, Inside and Outside

just as accurate as if taken from the actual center of the bar. Fig. 3 shows the boring bar body lined up in the center of the four tram ·ks which were put on the outside face of the eye while the tight line s still in place. Hermaphrodites may be used to check the distance l around the boring bar until it is exactly in the center. The same ocedure is followed at the other end of the bar where it projects rough the stern-tube bulkhead. After the bar has been securely lted in position, the job is checked again to make sure of the align- nt.

Figure 232 shows one of the bulkheads with a hole burned through. e four tram marks are measured from the tight line, and the boring bar lined up with these tram marks. Measurements are taken from the tram ·ks as shown in Fig. 233, to the side of the boring bar as indicated the reversed arrows. ——→DISTANCE X←—— The dis- nce "x" between the arrow points is the same all around the boring . This measuring must be done very carefully.

Figure 231 shows a boring bar set vertically. The men are boring e top gudgeon on the stern post. Note the strong backs at the upper d lower sides of the gudgeon. The strongbacks are secured to the ·tical channels welded to the rounding surface of the gudgeon.

Figure 230 shows a support welded to the "skeg" of the stern fra and bolted to the reduction-gear housing. This is done to hold t boring-bar assembly perfectly rigid while the boring is being don

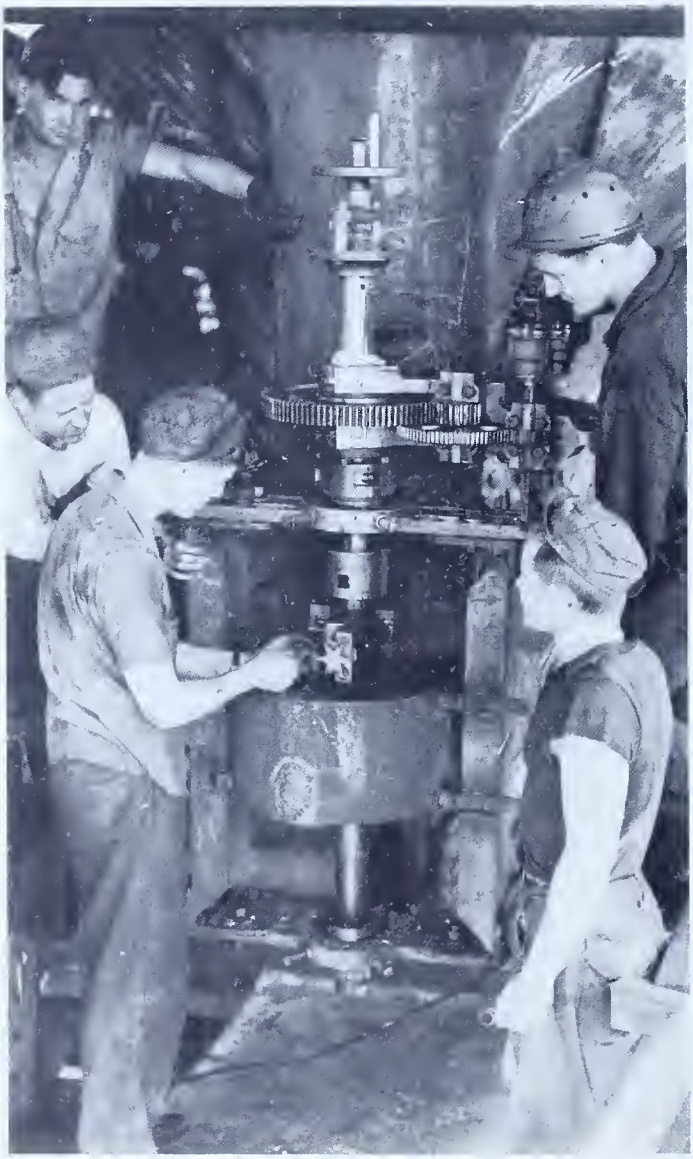


Fig. 231--Portable Boring Bar Set Vertical for Boring Rudder Gudgeon

The job of setti up a portable boring b may be summed up follows:

PROCEDURE (Applicable most cases)

1. Clear away all o structions, tool and loose materia which might interfe with the handling the boring bar.
2. Locate chain fal and planking at c venient points f quick and safe ha ling of the bor bar.
3. Strip the boring l of the yokes, t holder, reductio gear drive, air mot and hand-feed.
4. Lower the boring into the engine ro Wrap with bagging prevent injury to finished surface the bar.
5. Secure the boring in the chain f previously locate the after peak, balance the bar that it may be sw forward. Plank is placed to help slide the bar out through the eye in the st frame. Protect the bar with bagging, if necessary.
6. Support the outer end of the boring bar with planking and chain fa
7. Reassemble the yokes and other accessories, and get ready to ra the bar into boring position.
8. Estimate where additional spiders and supports should be secu to support boring bar.
9. Have flat or angle supports cut, and welded into position.

Bolt boring-bar spiders to supports, and line up the boring bar.

NOTE: Measure from outside diameter of boring-bar main body to the tram marks previously placed on the stern-frame eye and bulkheads. Use a steel scale and hermaphrodites. Keep the hermaphrodite scribing leg to a sharp point. Be careful to hold the tool at right angles to the center line of the boring bar. The measurements must be perfect if the stern tube is to be in correct alignment. Check with the leader.

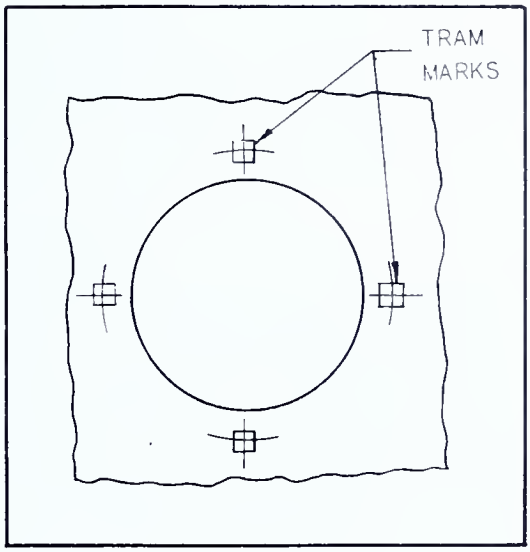


Fig. 232

Install the tool holder, adjust the air motor, connect the air lines, and recheck all fastenings to make sure the bar will remain in correct alignment. The boring bar should now be ready for boring the eye in the stern frame.

STIONS

1. A heavy boring bar should always be used where there is sufficient room to set it up. Why is a heavy boring bar more desirable than a light one?
2. What is the principal problem involved in setting a portable boring bar?
3. At what points are measurements taken to bring the boring bar central with the diameter to be bored?

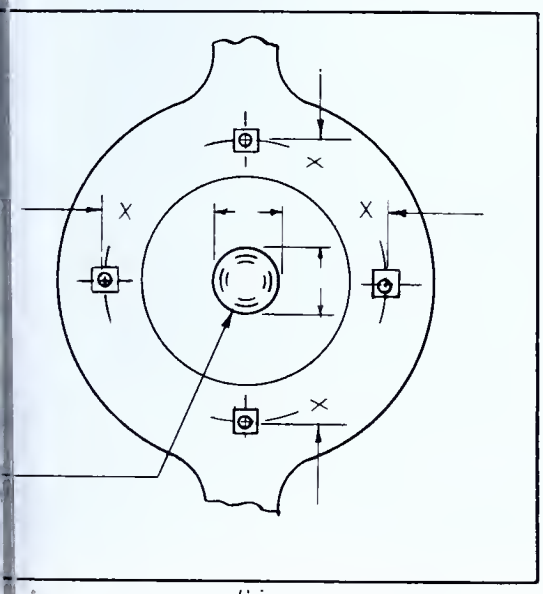


Fig. 233

4. Explain the reason for removing the fittings from the boring bar before setting through the stern-frame eye.
5. Point out the principal precautions to be taken when getting ready to set the boring bar through the stern-frame eye.
6. What is the purpose of the swivels and yokes on each end of a boring bar?
7. Explain the usual method of providing suitable places to which parts of the boring bar may be

bolted to hold the boring bar in position while the boring job is being done.

8. State at how many points supports for the boring bar are welded temporarily; explain the purpose of each support.

9. What would be the probable result if a boring bar slipped a little during the boring operation?

10. What is the correct procedure after the boring bar appears to be set central with the eye diameter?

Boring A Stern Frame

ACCURACY OF A BORING JOB

There must be no errors in the boring of a stern frame. The ste frame casting is "welded in" with the hull plates of the ship, aft which operation all the pieces become one unit. To ruin a stern fra means a loss of time and materials that is difficult to estimate. Bo ing a stern frame is a man-sized job which the mechanic must approa with the fixed idea that every move must be carefully and thorough planned. Mistakes are absolutely barred.

THE BORING JOB

Full instructions have been given for running a tight line. Fu instructions have been given for setting a portable boring bar. T instructions given here are to be followed after the boring bar is place, ready to bore the stern-frame eye and the bulkheads, which we shown in Fig. 220.

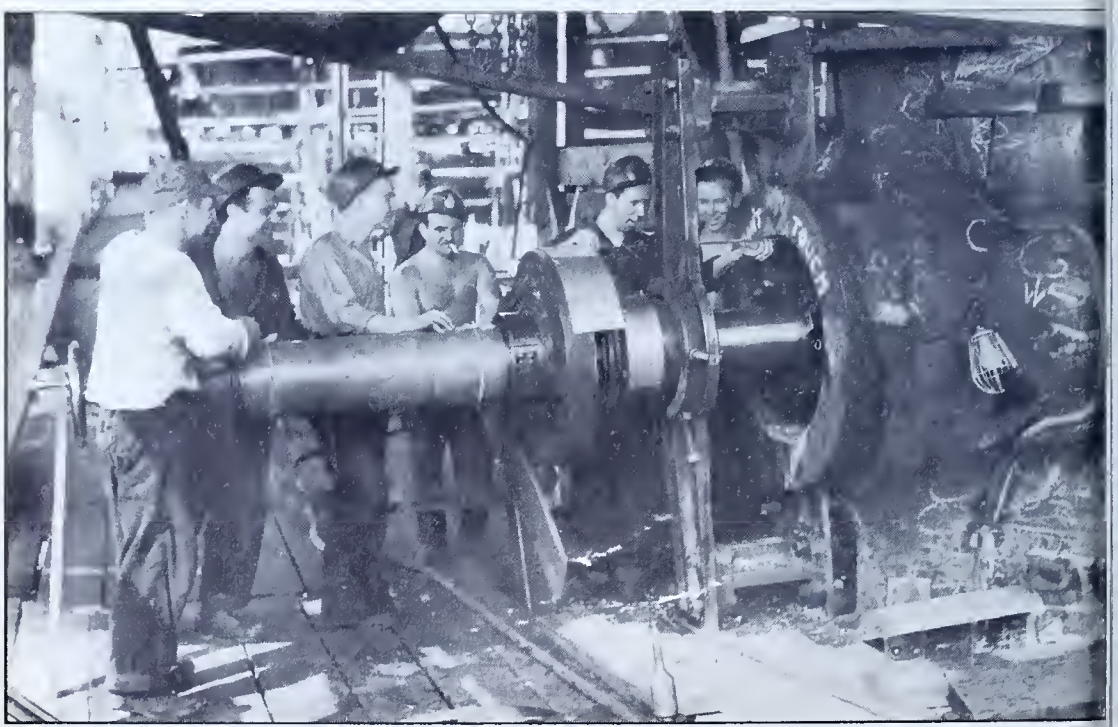


Fig. 234—Portable Boring Bar Set Horizontal for Boring a Stern Frame Eye

CEDURE

1. Adjust the tool holder and tool bit to the correct location. Turn the bar slowly to find where the high spots are on the inside of the eye. See Fig. 234.
2. Feed the tool into the full depth of the eye to make sure that there is plenty of clearance and that there are no high spots to foul the tool and throw the "set-up" out of line.
3. When everything seems to be clear, check with the leader.
4. Set the tool to take a 3/16" cut, and feed slowly to get the "feel" of the tool. A faster feed may be used if it is evident that the tool will "hold up" and that there is no "spring" in the "set up." (A cutting speed of 30 to 60 feet per minute is safe in most cases. Check with the leader on this point.)
5. Continue to take roughing cuts until the inside diameter of the eye "cleans up".
6. Check with the leader at this point. Check all spiders, yokes, and stools frequently to make sure there is nothing slipping.

NOTE: As soon as the hole is cleaned up, a check can be made with hermaphrodites from the circumference of the bore to the tram marks. This serves as a double check on the accuracy of the work.

Fig. 235--Checking the Diameter of a Stern Frame Bore

7. If the work is approved up to this point, continue boring diameter until within 1/8" of the correct diameter.

8. Bore the bulkheads up to this point as outlined above.

NOTE: At this point the stern tube should be brought out the job and carefully measured. As the diameter of bore in the eye must be slightly smaller than the st tube diameter, a very close measurement must be tak

A very slight change in temperature affects me in that all metals are sensitive to heat and cold. stern tube that measured 30" in diameter in a w machine shop would very likely measure .005 less w taken to the ship ways to be installed.

The cold air in the winter months would shr the metal, and it would be too small for the bored h in the stern frame unless the measurements were ta when both stern frame and stern tube were the same t perature. This is the reason for bringing the st tube to the ship ways to be measured before the fin cut is taken in the bore.

When measuring the stern tube to get the size the diameter to bore, proceed as follows:

(a) With a pair of outside calipers, carefully meas the diameter of the stern tube.

(b) Lay the outside calipers on a level surface and inside micrometers to the points of the calipers

NOTE:

Special inside micrometers are used for this job. There is an offset in the micrometer which will clear the boring bar. See Figs. 235 and 236.

MEASURING THE INSIDE DIAMETER OF THE STERN-FRAME EYE.

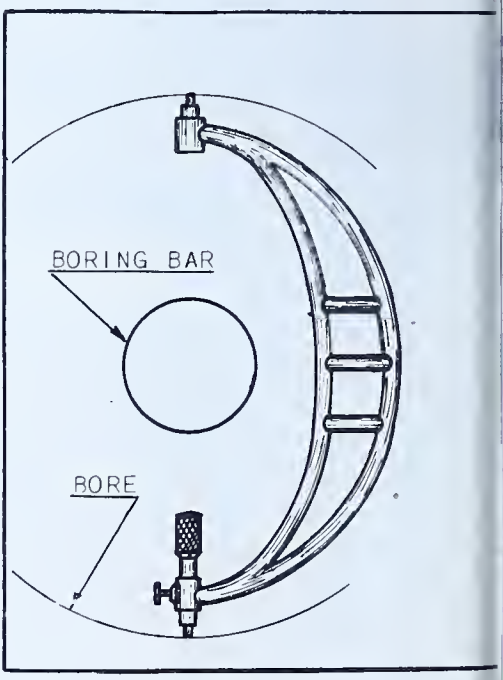


Fig. 236

(c) When the setting has been accurately determined, reduce the size .008 to allow for a press fit. This must be done very carefully.

(d) Now proceed with the finish cut for about 1/8" and check with the micrometer. If the size is correct, proceed. If too large, back off and try again. DO NOT CUT IN LENGTHWISE FOR MORE THAN 1/8" BEFORE TRYING FOR SIZE. See Fig. 235.

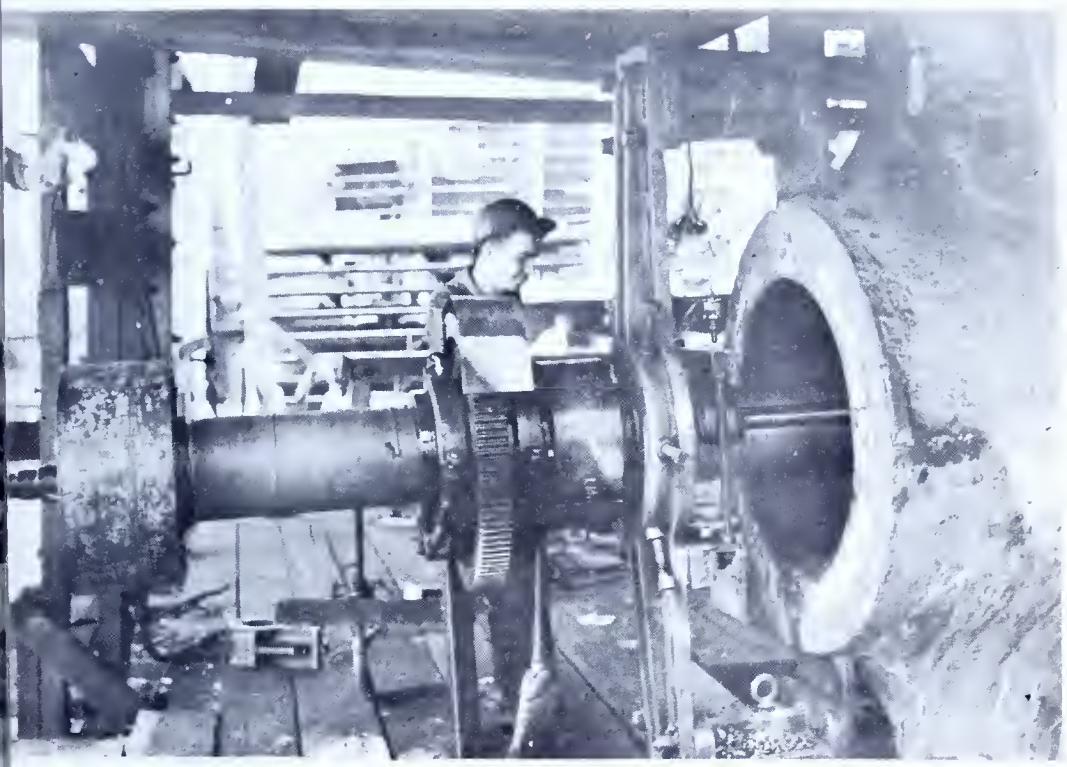


Fig. 237--Finish Cut in a Stern Frame

(e) When the bore checks correctly with the mikes, proceed with the finish cut. Watch the tool carefully as the boring proceeds. If the tool begins to burn, STOP. Check with the leader if in doubt as to how to proceed. See Fig. 237.

If the finished hole is bored tapering, the stern tube will likely seize when being "pulled in"; so every precaution must be used to have a straight hole.

NOTE: When finished with boring, do not move the boring bar until the diameter of the hole has been checked and approved by the leader or inspector.

QUESTIONS

1. When adjusting the tool holder to begin taking a cut, what precaution should be taken to prevent the tool's "fouling" the work?
2. How heavy should the tool be set in for the first cut in a stern-frame eye?
3. At what speed is it considered safe to start a roughing cut?
4. What is understood by the phrase "clean up the inside diameter" of a boring job?
5. Explain the usual causes for the boring bar's getting out of line during a boring operation.
6. How is the rough bore checked for accuracy with the center location before proceeding with the job?
7. How much stock is left for a finish cut in a rough-bored "eye"?
8. State the usual allowance for a press fit between the "eye" and the stern-tube diameter.
9. Explain how the measurement is taken for the finished diameter of the bore in the "eye".

"Pulling in" A Stern Tube

PURPOSE OF A STERN TUBE

The stern tube is the shell for the lignum vitae, tail-shaft be ing. The stern tube varies from 8 to 20 feet in length. The outs diameter is stepped, that is, the end that fits in the stern-frame is smaller than the end that fits in the stern-tube bulkhead.

CORRECT FIT FOR A STERN TUBE

When the stern-frame eye and the stern-tube bulkhead are bore the finished size, the stern tube should "pull in" under pressure, cause the stern tube is turned .008 of an inch larger than the ste frame eye at the stern end (see point "a" Fig. 238), and .003 lar than the stern-tube bulkhead at the bulkhead end (See point "b", F 238). Figure 239 illustrates a tube partially pulled into pla

USING THE CHAIN FALLS

When the bored holes in the stern-frame eye, stern-frame bu head, and the intervening bulkheads have been brought to size to al for a pressed fit as outlined in the last paragraph, the stern t is lowered into the engine room. Chain falls are placed in posi to take the stern tube off of the crane. Sometimes as many as 8 o chain falls are used to carry the stern tube as it is worked bac its place from one chain fall to another. The stern tube must be tected with bagging to prevent scoring the finished surface while tube is being handled by the chain falls.

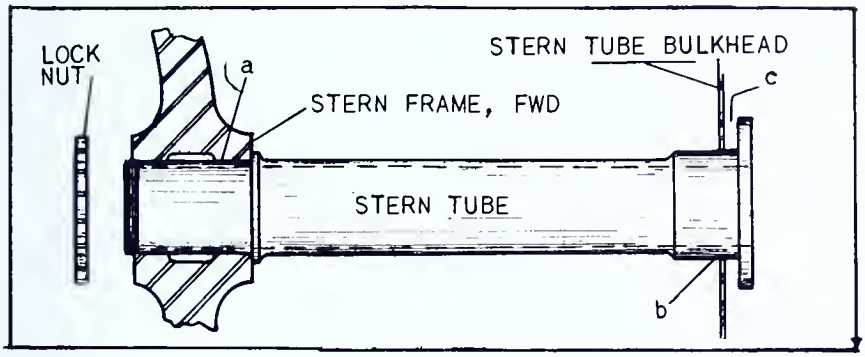


Fig. 238--Stern Tube in Place

EPARING TO "PULL IN" THE STERN TUBE

Fugure 239 shows the stern tube partly drawn in through the stern-ame eye and the stern-tube bulkhead at "a" and "b". A heavy bolt is own at "c". The bolt extends from the outside of the bulkhead end of e stern tube, through a strong back "d", and all the way through the ern tube and the strong back "e". A hydraulic ram "f" is secured to e outside of the strong back "e". The ram draws the stern tube into ace.

Two cradles, Fig. 240, are used under the pull bolt to keep it actly central in the stern-tube bore. The cradles are made an easy t for the stern-tube bore and the pull bolt. One cradle is placed the stern-frame end, and the other is placed at the stern-tube, lkhead end. See "x" and "y", Fig. 239.

ULLING IN" THE STERN TUBE

The hydraulic ram works against the washer and nut at "g" and has effective draw of about 10 inches. When the ram has reached the 10" mit, another washer (10") "h" is placed between the strongback and the rst washer under "g" and another 10" section of tube is drawn in. This repeated until the stern tube is completely drawn into place, making a tal-to-metal joint at the stern-tube shoulder and forward end of eye. e Fig. 238.

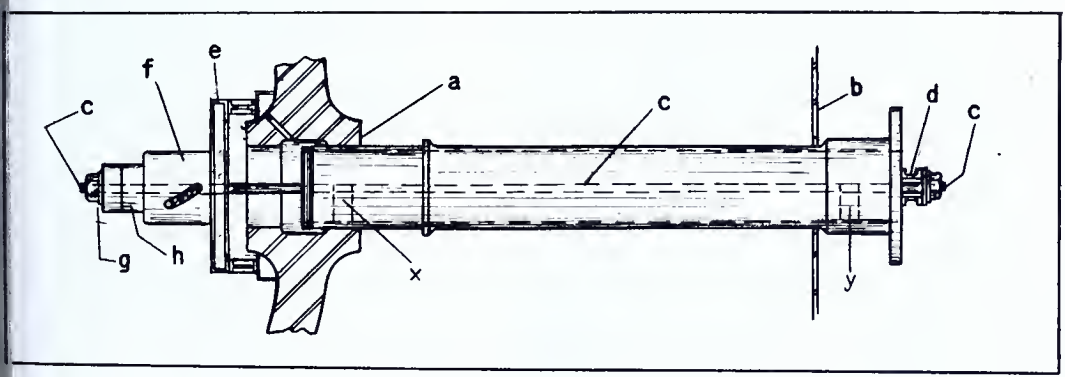


Fig. 239--"Pulling In" a Stern Tube

A pressure of not less than 3500 pounds registered on the gauge is standard for a correct fit. This pressure may run as high as 6000 pounds, but it must not be less than 3500 pounds. A pressure gauge is connected to a hydraulic pump which acts on the ram. The gauge should be watched constantly for variations which will indicate too much or too little pressure.

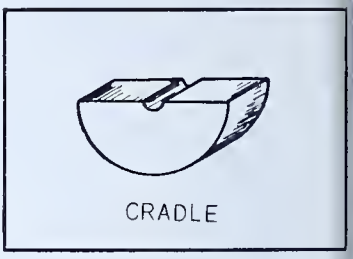


Fig. 240

The lock nut, Fig. 241, has in the circumference, several machined notches into which the spanner wrench fits when the nut is being installed or removed. When the lock nut has finally been "snugged home", a hole is drilled in the face of the stern-frame eye and tapped out for a lo stud. The location of this hole brings the lock stud at the bottom one of the notches. After the lock stud has been secured in place, ta weld it fast. See "a" Fig. 241.

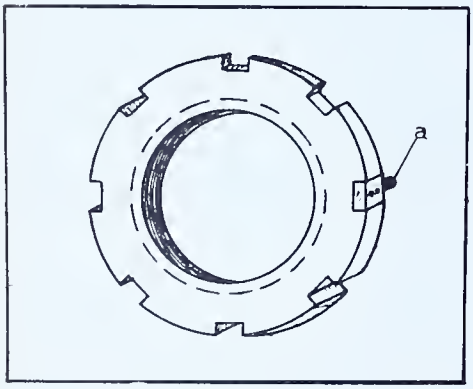


Fig. 241--Lock Nut

When the stern tube comes to the job, it is packed with sawdust keep the lignum vitae beari blocks from drying out a cracking. Never remove t sawdust until ready to pu the stern tube into plac While the operation of pul ing in a stern tube is pr ceeding, the job is inspect and criticized by the Americ Bureau of Insurance, or t Lloyd Insurance Company, a the agent of the shipowne This is done to make certa that the job will conform all underwriter requirement

The operation of pulling in a stern tube may be summed up as follows

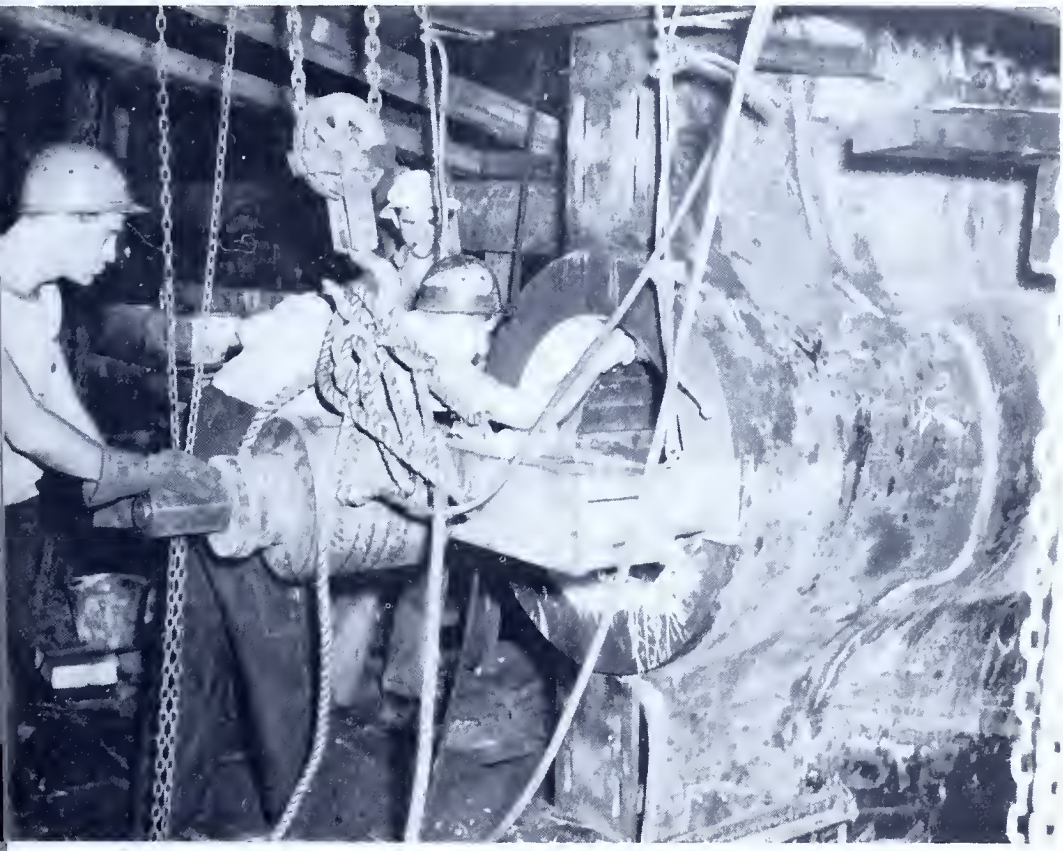
TOOLS AND EQUIPMENT

1. Hydraulic pump
2. Hydraulic ram
3. Strongback assemblies
4. Pull bolt
5. Saddles for pull bolt
6. Washers for pull bolt
7. Stern-tube nut wrench
8. Drill for lock stud
9. Air drill
10. 30-pound sledge
11. Chain falls
12. Melting ladle
13. Pouring ladle
14. Heating torch

MATERIAL

Planking for skids and platform

White lead and oil
Lock stud
Tight metal



g. 242--Inspecting the Progress of the Stern Tube Through the Eye

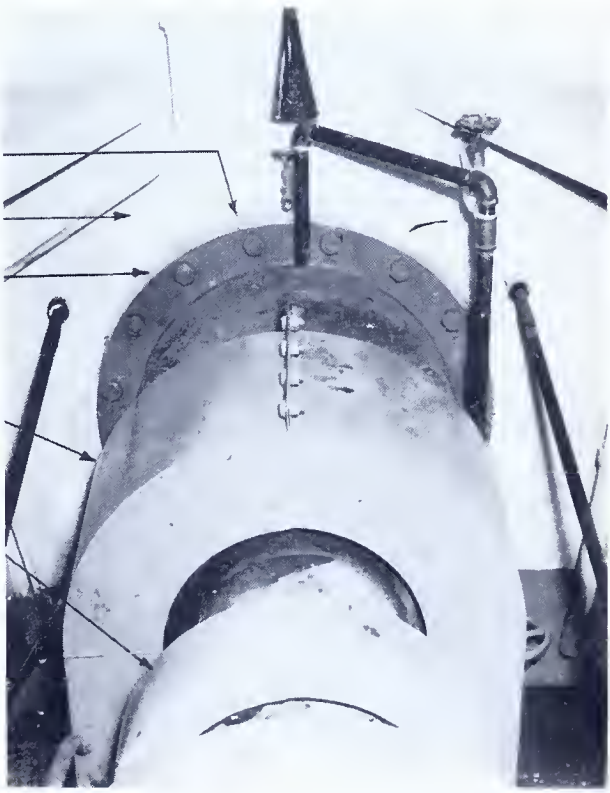


Fig. 243--Shows the After End of the Stern Tube in the Shaft Alley

Fig. 243

PROCEDURE

1. Lower the stern tube into the engine room.
2. Receive the stern tube in one or more chain falls, and swin to the next chain fall, passing the tube aft.
3. Enter the tube in the bulkhead hole, and pass it through t the stern-frame eye.
4. Apply white lead and oil to the tube, bulkhead, and eye sur faces.
5. Install the pull bolt, and adjust strongbacks and hydrauli ram.
6. Pump pressure until the pull bolt takes hold.
7. Now examine all equipment and fastenings to make certain th tube is entering "fair".
8. Pull the tube in as outlined in the text of this instructic sheet.
9. When the tube is in place, check with the inspector for hi approval.
10. If approved, remove strongbacks, hydraulic ram, and pull-bol clear the platform for installing the lock nut.
11. Drill through the stern-tube flange for studs, and tap hol to suit.
12. Install studs with grommets and nuts on the after side of ster tube bulkhead. See Part II, Making a Watertight Joint, Fi 145 for application of stud and grommet.
13. Place a metal band around the flange of the stern tube in read ness for pouring tight metal.
14. Build up a clay mud seal all around the ring to prevent the tig metal's escaping when it is poured into the joint.
15. Build up (on top of the metal band) a clay mud cup into whi the tight metal may be poured.

    NOTE: While the metal band is being placed and the mud seal being installed, the tight metal should be made read The tight metal is melted in a ladle over a heatin torch. The metal is considered to be hot enough to po if a pine stick takes fire when inserted in the melti metal. This test indicates approximately a temperatu of 535° to 550° F.

16. Pour the tight metal into the cup previously prepared. Po fairly fast to insure a good joint and avoid air pockets.

    NOTE: In cold weather the bulkhead and the stern-tube flan should be preheated to prevent chilling the metal as is poured.

17. Remove the band and calk the tight metal with a rough calki tool. This procedure will tighten up the joint and make certa there are no gas or air pockets.

NOTE: In the event that a gas pocket or an air pocket is discovered, the metal may have to be melted out and repoured. This is almost sure to be necessary if the pocket is found on the bottom side of the joint.

18. Install washers and nuts on the studs, and draw up tight. See Fig. 243.

19. Fill up the after peak with water from a shore-line hose to make the necessary test for leakage around the joints between the stern-tube flange and bulkhead and the stern tube and stern-frame eye.

QUESTIONS

1. Why is a forced fit necessary between a stern-tube diameter and the stern-frame eye?
2. How much difference in diameter should there be between the bore in the stern-frame eye and the after end of the stern tube?
3. Explain how a stern tube is carried back into position after it is lowered into the hull.
4. What protection should be given a stern tube during the operation mentioned in step 3?
5. What is the purpose of the two cradles which are placed under the pull bolt in the stern tube?
6. State the reason for pulling in the stern tube with a pressure of 3500 lbs. registering on the gauge.
7. When is the sawdust removed from the inside of the stern tube? Why is it not removed sooner?
8. When is the stern-tube job inspected and by whom?
9. What is meant by the word "fair"?
10. Why is a small space left between the stern-tube bulkhead and the stern-tube forward flange? ("c" Fig. 238)
11. Explain in as few words as possible how and why tight metal is poured at the forward end of the stern tube.
12. How are the stern-tube joints tested for leakage after the installation is complete?

Installing A Propulsion Motor

PROPULSION MOTOR DRIVE

The propulsion motor is keyed to one end of the line shaft, and the propeller is keyed to the other. When the propulsion motor turns, the propeller turns at the same speed and so moves the ship through the water. The propulsion motor (See Fig. 244) is electrically operated, very much like any other electric motor except that it is installed on the forward end of the line shaft; the line shaft thus becomes the axle upon which the rotor turns. The foundation is installed according to the location given on the blueprint. Figure 244 shows the motor hous-

ing and the line shaft housing. The motor is inside the large housing Note handles which are used to grasp the housing sections when openi or closing the housing assembly.

Unless the installation of the propulsion motor is correct in t smallest detail it will not be passed by the inspector. The propulsi motor is lowered into the ship by ship riggers, set back as far off the foundation as possible to give clearance for installing the roto and after the rotor is install the entire stator unit shifted to the correct positi on the foundation.

Fig. 244--Propulsion Motor and Line Shaft.

PRECAUTION

Every precaution should taken when installing the stat to make sure that there is damage caused to either t rotor or the stator. It advisable to place shims arou the inside of the stator serve as guides when slidi the rotor into place.

INSTALLING THE MOTOR

At the time the final i stallation is made, the li shaft has already been installe See Fig. 220. The propulsi motor must be set directly wi the line shaft for the li shaft cannot be moved. Th calls for extremely caref measuring. The rotor shaft set in line with the line shaf As the propulsion motor weig sixteen tons or more, the enti job must be done carefully.

When the motor is set position and approved by t inspector or the leader, t job of fitting chocks is begu When the chocks are fitted, t corners are drilled and ream for fitted bolts; the bolts a installed and drawn down tightly; and then the rotor shaft is revolv and "indicated" to make sure it is in perfect alignment with the li shaft.

A piece of insulation approximately .125" thick is placed betwe the top side of the chock and the pedestals of the propulsion motor the forward bearing. After the chocks are fitted and are found to satisfactory, they are removed and an amount equal to the thickness

the insulation is machined off of the top of each chock. This job must be done very carefully or the alignment of the other chocks will be thrown off.

The fitted bolts through the forward bearing are insulated at the point where the bolts pass through the pedestal and the upper side of the chock. These points are insulated to prevent a ground on the forward bearing. See Fig. 245 and 246.

If an arcing condition should be set up, the shaft and the babbit bearing in the propulsion motor would be scored and both would have to be replaced. Such an arcing condition must be made impossible by proper insulation.

TOOLS

1. Drills of the correct size
2. Corner drilling machine
3. Reamers for couplings (taper and straight)
4. Reamers for hold-down bolts
5. Open wrench set
6. Scrapers
7. 6" scale
8. Thickness gauge (.002"-.060")
9. 24" inside calipers
   or
   Special telescopic gauge

MATERIALS

Shim stock

10. Taper gauge (0"-.390")
11. Center punch
12. Machinist's hammer
13. 10-lb. maul
14. 20-lb. maul
15. Necessary taps
16. Jacking screws
17. Diesel side jacks

Fig. 245--*Line Shaft Bearing and Pedestal*

GENERAL PROCEDURE

1. Find the correct location of the rotor unit on the foundation from the blueprint. Level the unit on chocks or wedges, or both, preparatory to bolting down.
2. Align the couplings on the rotor shaft and the line shaft.
3. Check with the leader.
4. Fit chocks as previously instructed (See Part I) under the bearing pedestal of the rotor.
5. When the chocks are correctly fitted, check with the leader.
6. If the work up to this point is approved, proceed to drill and ream the corner holes for fitted bolts.

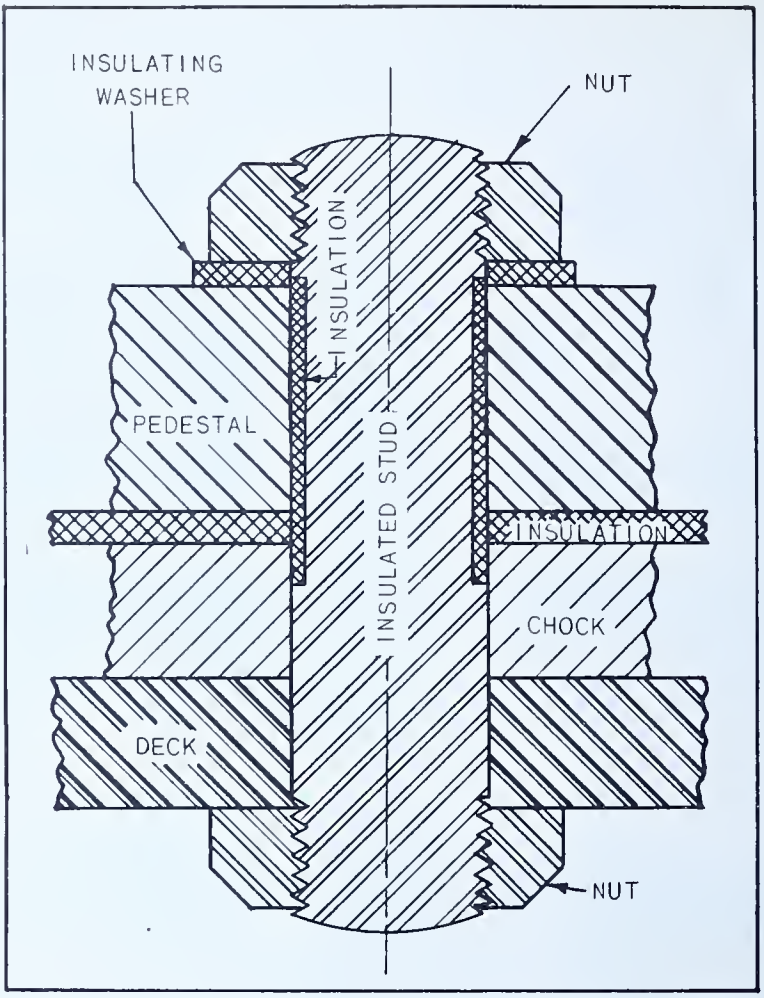


Fig. 246--Typical Insulated Stud Installation

7. Install fitted bolts and draw the nuts down tightly. Be sur to install the insulated bolts correctly.

8. Check the alignment of the rotor shaft with the line shaf to make sure there has been no error.

9. Using jacks or wedges, line the stator up with the rotor an check the spacing between the rotor and the stator with a 12 tapered wedge gauge. See Fig. 247.

   NOTE: The propulsion motor is set "up and down" to align wit the line shaft .005 of an inch above the center. Thi is to allow for wear as the motor "settles" in the bear ings. The fore-and-aft location is found on the blue print.

10. When the rotor and stator appear to be in perfect alignment al around, check with the leader. If the alignment is correct fit the chocks under the stator base.

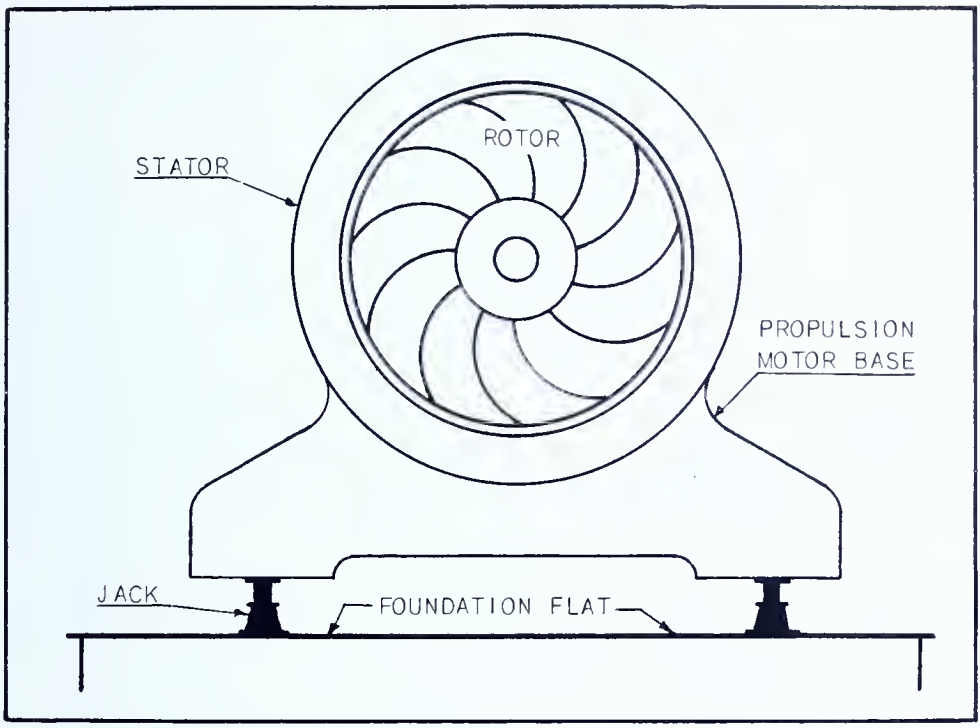


Fig. 247--The Stator is Jacked Up True With the Rotor

11. Drill, ream, and install fitted bolts on the four corners. Pull the nuts up tightly. Use every precaution to insure the nuts' being pulled up to the limit.

12. Re-check the spacing between the rotor and the stator.

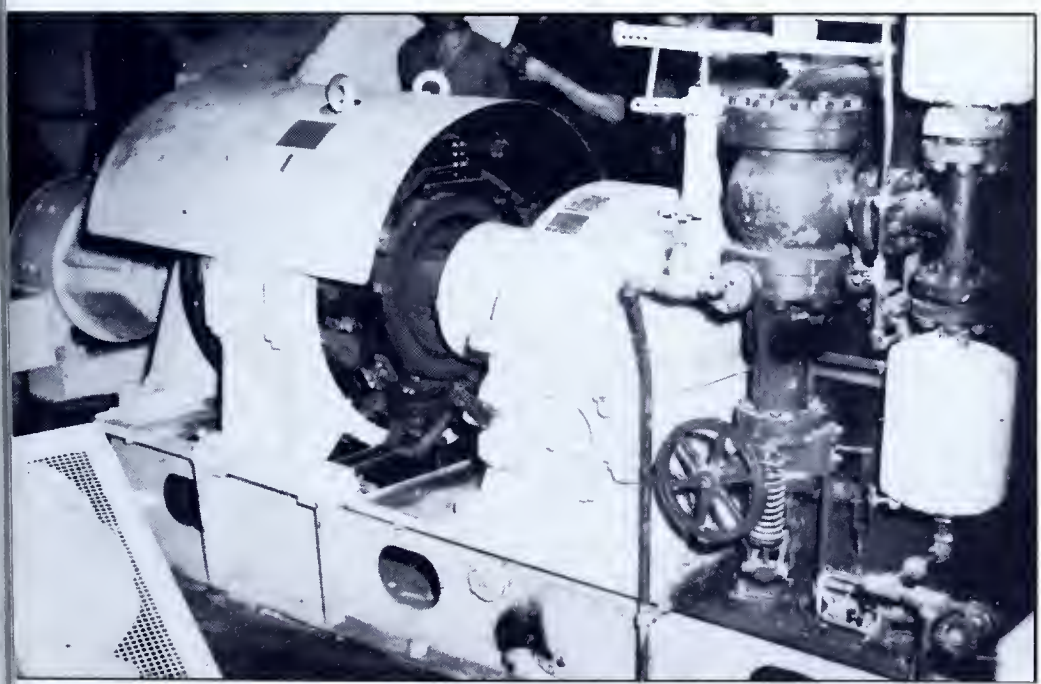


Fig. 248--Typical Turbo-Generator Unit

12. Re-check the spacing between the rotor and the stator.
13. Call the leader, and have the job inspected up to this point.

Figure 248 shows a turbo-generator and exciter set. Several of the units are installed in the engine room or adjacent to the engine roo and they generate power which is used to drive the propulsion motor a numerous other electric motors throughout the ship. The ship lighti system also draws current from the turbo-generators.

QUESTIONS

1. When a propulsion motor is being installed, why is the rotor aligned before the stator?
2. Explain the procedure of aligning the stator with the rotor.
3. How often is the spacing checked between the rotor and the stator?
4. Why is the stator aligned with the rotor in such a way that the center line of the rotor is .005 of an inch above the center of the stator?
5. Describe a diesel side jack.

Installing Fan And Motor For Air Cooler

FAN REDUCES TEMPERATURE

The temperature in the vicinity of the propulsion motor norma varies from 150 to 180 degrees Fahrenheit. As the propulsion motor installed in the engine room, it is subject to high temperatures cau by heat radiated from the steam lines and absorbed by the surround atmosphere. In winter these temperatures are reduced somewhat by coo weather; but in summer, and in southern climates especially, the t perature around the propulsion motor must be reduced or the motor w run so hot that it may burn the bearings.

An air cooler is installed in a convenient place; a fan and mo are connected to the air cooler by a "circulating duct"; and the a around the motor is drawn through the air cooler continuously, bring the temperature down to about 115° Fahrenheit. See Fig. 249.

CORRECT INSTALLATION

The importance of correct installation of the air-cooler fan can be stressed too much. When the ship is in service, there is an extre ly heavy load on the propulsion motor. If for any reason the fan motor should stop working, the temperature would likely go so high t the motor windings would be in danger of burning out. If this sho happen while the ship is at sea, the results may be easily imagined.

FAN AND MOTOR UNIT

The fan-and-motor units are usually mounted on a base as one un Sometimes the fan-and-motor units come separate. In either case the w involved in making the installation is much the same.

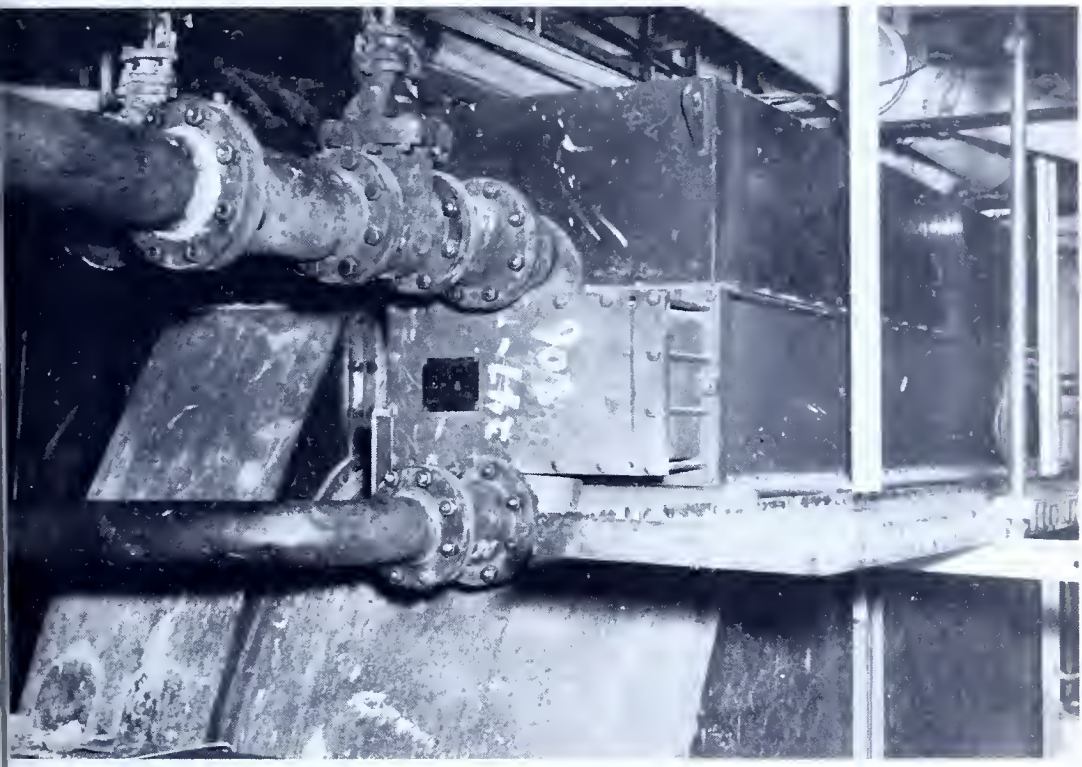


Fig. 249--Westinghouse Air Cooler Unit

Figure 249 shows two pipe lines through which sea water is circu-ated for the purpose of cooling the air that is blown through the air-ooler unit installed above the propulsion motor housing. The air duct rom the fan to the cooler unit is at the left. The fan and motor (not nown in the photograph) are mounted below and close to the propulsion-otor housing.

The shipfitters build the foundations; and when the unit is ready r installation, the ship riggers place it. The location on the founda-on is laid out from the blueprint by the outside machinist. The fan y be anywhere from 38" to 52" in outside diameter. The revolutions r minute may be about 1175 for large motors and about 1400 for small tors. The smaller fans operate at higher speeds. The foundation is stalled on the engine-room tank top just aft of the main condenser.

Figure 250 shows a General Electric fan and motor. The motor is dicated at "a", the blower at "b", the intake duct at "c", and the scharge duct at "d".

Figure 251 is a photograph of a General Electric Air Cooler. e blower discharge (hot air) is shown at "a"; the cooler tank (to duce temperature) is indicated at "b".

OCEDURE

1. From the blueprint, locate the correct position of the unit on the foundation.

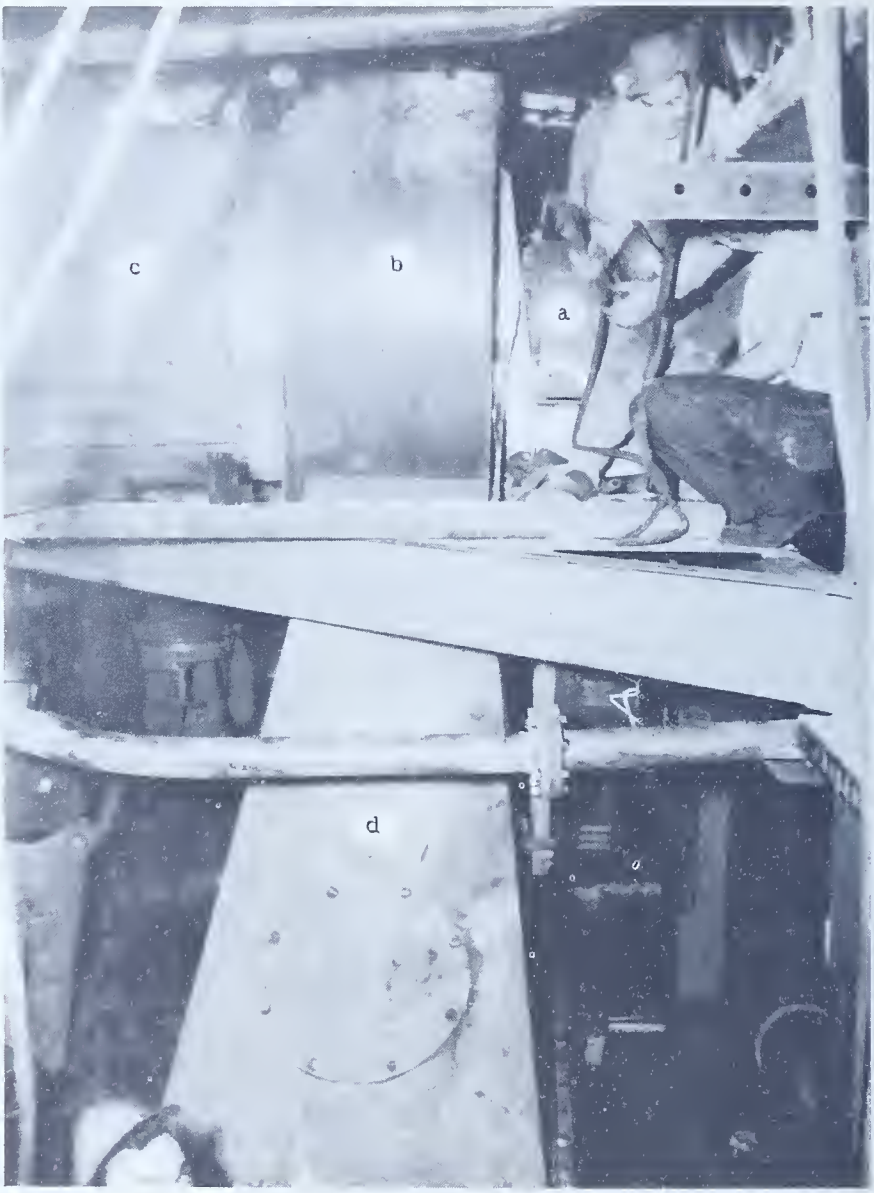


Fig. 250--General Electric Motor and Fan

2. Level the unit on wedges preparatory to bolting down.
3. Drill the corner holes for fitting bolts through the foundatio

   NOTE: Usually the unit is bolted down on metal chocks, b sometimes a wood cushion of suitable thickness is us to reduce vibration. (In this case metal chocks a not used.)
4. Fit corner chocks; drill, ream, and install fitted bolts; a draw down.
5. Fit the remainder of the chocks.
6. Have an inspector check the job for accuracy.

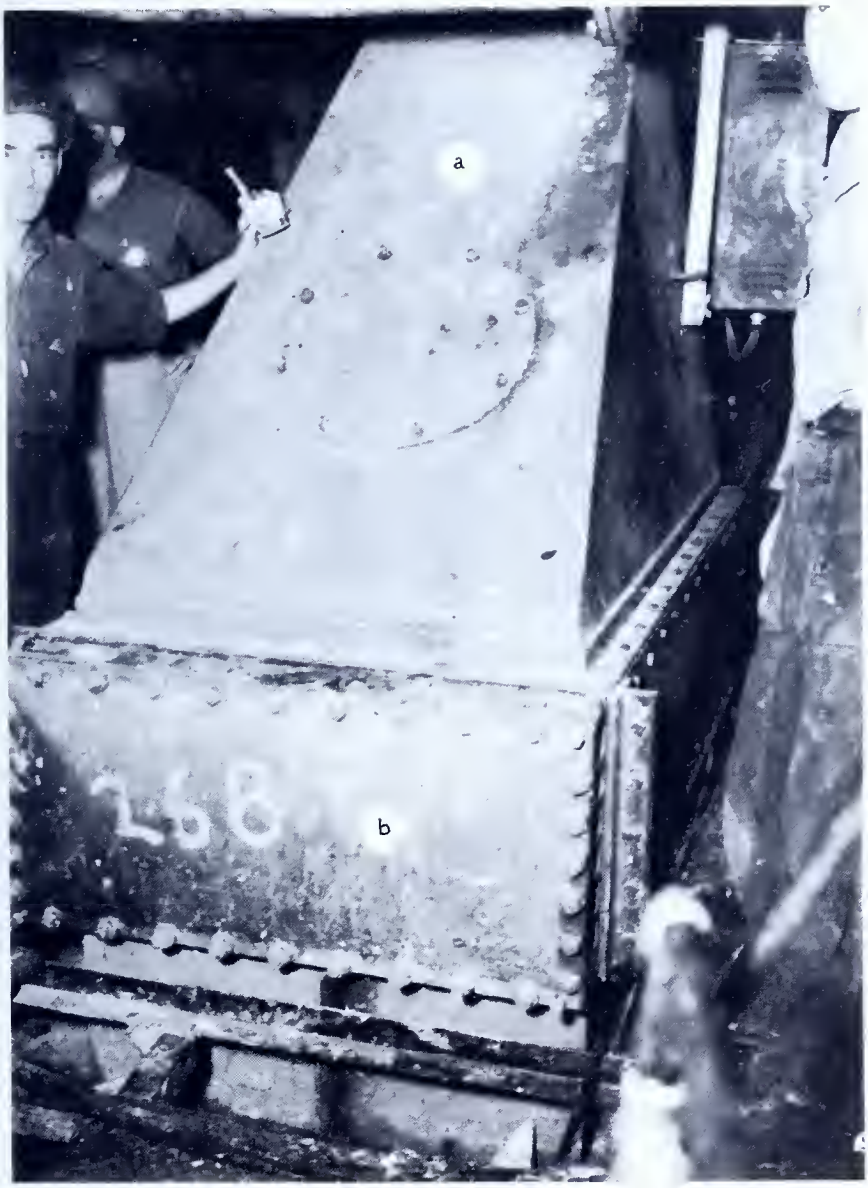


Fig. 251--General Electric Discharge Duct and Cooler Tank

Installing A Steam Boiler

CRIPTION OF A STEAM BOILER

Tankers and certain types of cargo ships are usually equipped with the ler which is described here. The boiler is built in the shipyard by boiler-makers. When completely finished, the boiler is set on the p by the riggers and bolted down by the outside machinists.

The boiler is known as a Babcock and Wilcox, oil-fired, tubular-der type. This unit weighs approximately forty-six tons when com-ted. Fig. 252.

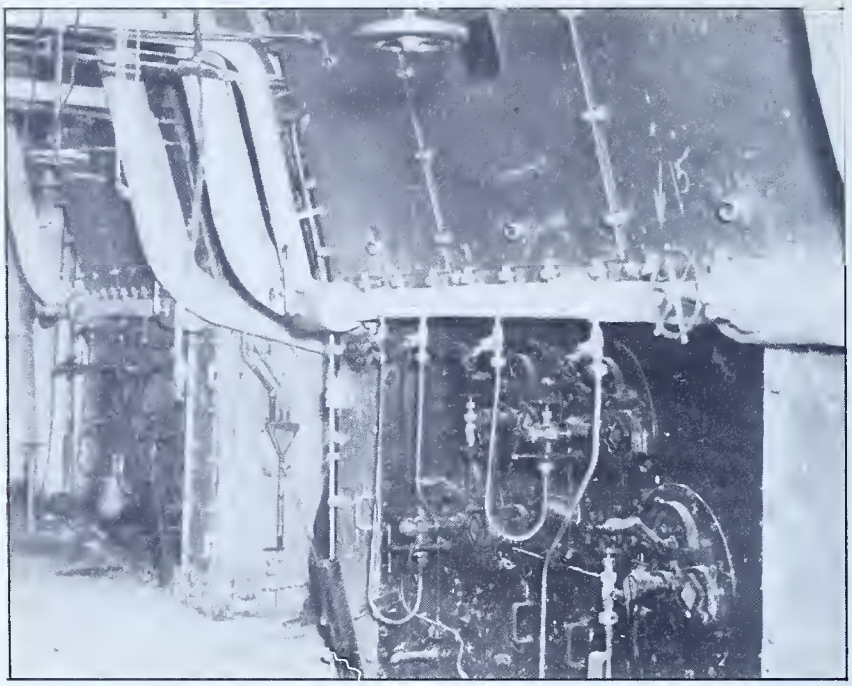


Fig. 252--Babcock and Wilcox Oil Boiler

THE FOUNDATION

A foundation is constructed in the boiler room. The boiler roon a tanker is located in the after end. The boiler room in a cargo s is located amidships. The shipfitters build the foundation, whihh i heavy construction. It is finished off with two steel channels that s port the boiler, back and front. The foundation seat is a channel al 14" wide and 18" high. See Fig. 253.

The channel is welded securely to the foundation plate, and boiler is bolted down to the channels. The channels are called "stoo

Six 1-1/4" bolts are placed through each of the four bottom cor of the boiler frame and the foundation stools.

LAYING OUT THE BOLT HOLES IN THE STOOLS

The locations of the bolt holes in the stools are taken from blueprint. Before laying out the holes in the stools, however, boi makers check the base of the boiler to make sure the holes in the t match with the hole locations on the blueprint. If there is any d crepancy, the layout is corrected to agree with the boiler base. Fi 254 is a top view of a foundation stool on the port side of the sh A similar foundation is on the starboard side right next to the f foundation. Two boilers are installed with about 3 feet between adjacent walls.

When the machinist lays out the boiler locations, he takes measurements from the ship center line, the boiler center line, and foundation center line.

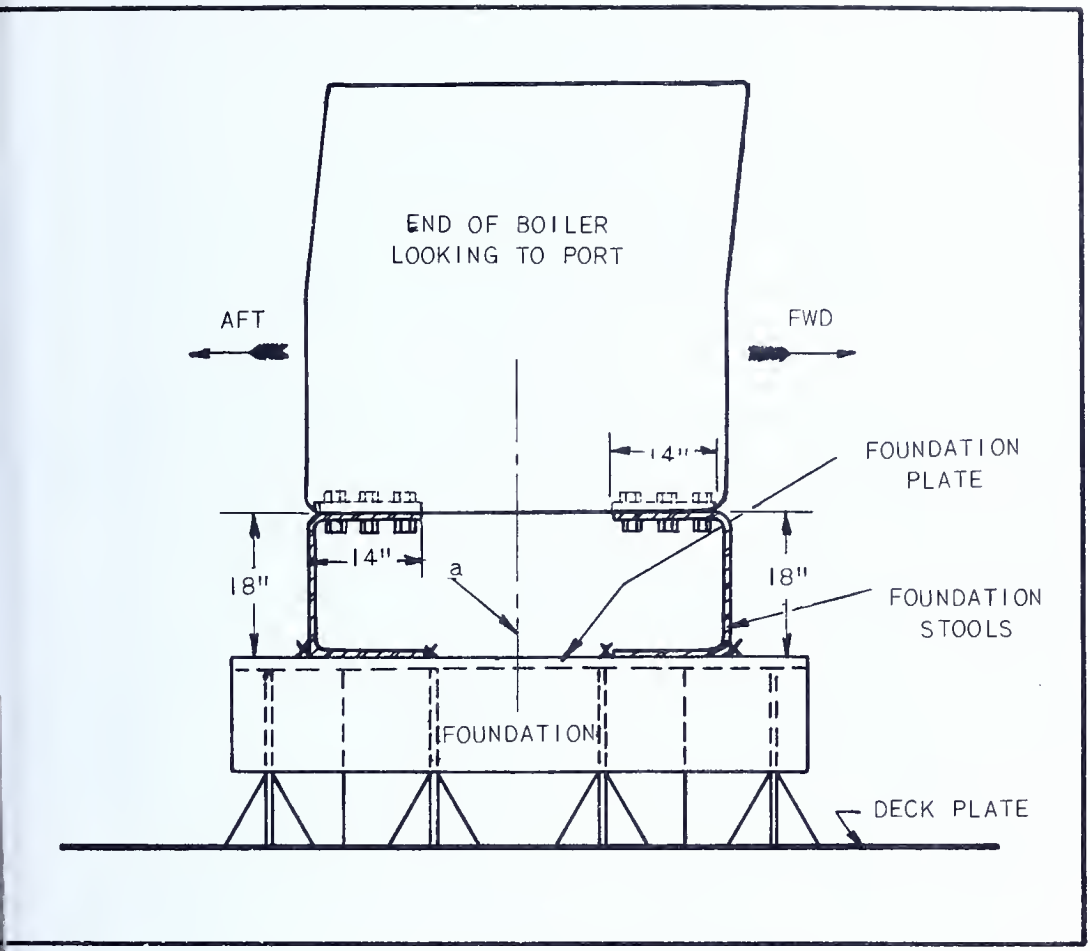


Fig. 253--Boiler Foundation Setting

TING THE BOILER

The boiler is picked up by the shipriggers and set on the foundation ler the supervision of the outside boiler-maker leader. This is not ne until after the holes are drilled in the foundation stools. A layer sealtight cement about 1/8" thick is spread on the surface of the ndation stools with a trowel. When the boiler is set on the stools, cement forms a cushion for the boiler and seals any uneven places on surface. The cement hardens quickly, and thus a solid, durable joint sformed between the foundation and the boiler base.

Figure 252 shows various valves, gauges, and controls which are in- tlled by mechanics especially trained for this purpose.

CAUTIONS

Certain precautions must be observed when installing any of the ges, valves, and other parts mentioned above.

(a) Examine the fittings closely to find if right-hand or left-hand threads are cut on the connections.

(b) Be very careful in handling brass fittings not to damage fine threads.

(c) Use a wrench of the correct size on all fittings, and see t the wrench fits closely. (Some wrenches may be "sprung" though they are stamped the correct size.)

(d) Follow the directions given by the manufacturer or the sh building company's blueprints.

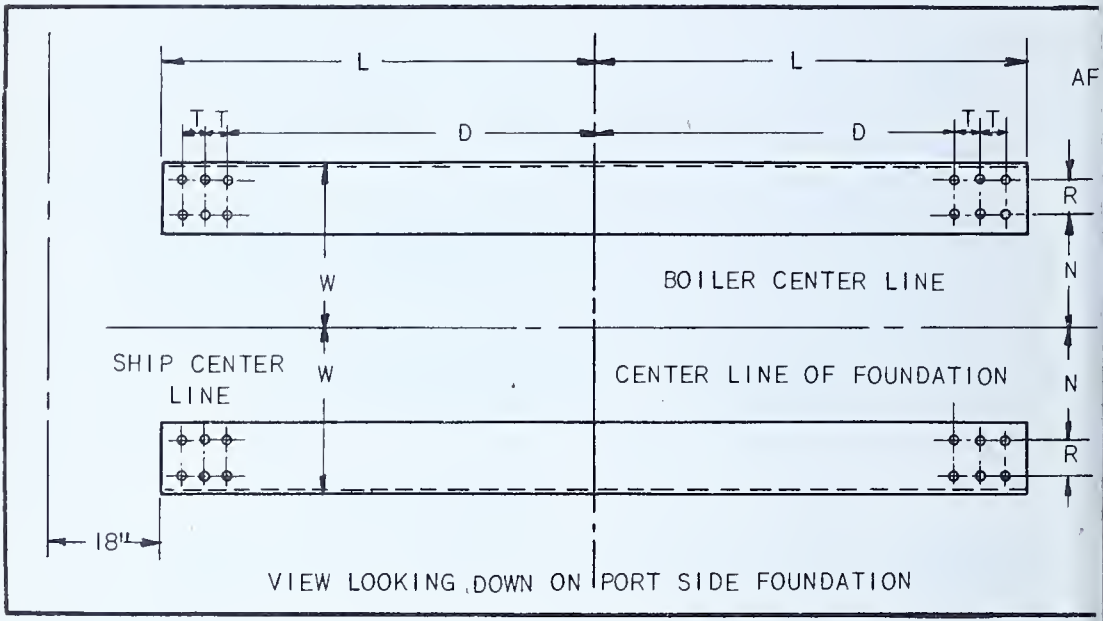


Fig. 254--Plan View of Steam Boiler Foundation

Many of these accessories appear to be simple in form and do seem to require any special knowledge to install. This is far from tr Each particular piece of equipment requires correct handling and care treatment.

As an example of the importance of working carefully and correct consider the work of installing a Bailey feed-water regulator. purpose of the regulator is to control the amount of water fed to boiler so that it will not run dry and cause burning of the tubes. regulator also prevents an excess of feed water which causes "wet" st and damages turbine fins or cracks a cylinder head.

* Bailey Feed Water Regulator Instructions

Principal of Operation - See Fig. 255

The Bailey Thermo-Hydraulic Feed Water Regulator depends for its peration upon the fact that the volume of a given weight of low pressre steam is far greater than the volume of the water from which that team was made. The water which operates the regulator is sealed in a losed system formed by the annular space between the inner and outer enerator tubes, the connecting copper tubing, and the metal bellows of he regulating valve.

When the regulator is placed in operation, heat from steam in the pper portion of the inner generator tube causes the surrounding water o flash into steam. This forces water out of the annular space in the enerator through the connecting tubing into the metal bellows which xpands and opens the regulating valve.

If the boiler water level tends to rise, cold water from water storge leg J rises up into the inner generator tube. This cold water plus adiation secured from the fin surface of the outer tube causes steam in he annular space to condense, thereby reducing the pressure in the closed ystem and allowing the spring to close the regulating valve.

In normal operation, the regulation valve adjusts its position to orrespond with the rate of steaming as reflected by slight changes in ater level and a continuous feed is delivered to the boiler.

How to Fill Generator When Valve is Above Generator

1. Jack valve open by means of handjack K.
2. Disconnect tubing R from metal bellows D.
3. Remove Guard H from bellows D, and place bellows in large bucket full of water.
4. Compress bellows many times with open end up until all the air is removed and bellows is filled solid with water.
5. Insert end of tubing R in bucket of water along with bellows.
6. Remove generator plug G, and draw on opening until water syphons from bucket out through generator.
7. Allow water to run until all air is carried out of line, and then insert plug G.
8. With bellows under water, place Guard H over bellows and connect end of tubing R to bellows. *Make sure that end of tubing R and bellows are completely submerged during this operation so that no air gets into the system.*
9. Replace guard H, and bellows on valve.
10. Release handjack K so that valve spring is free to close valve.
11. Remove generator plug G, and permit excess water to run out.
12. Replace plug G and make sure that connections at both ends of copper tubing, as well as plug G, are made up tight.

*hrough the courtesy of Bailey Meter Company, Cleveland, Ohio.

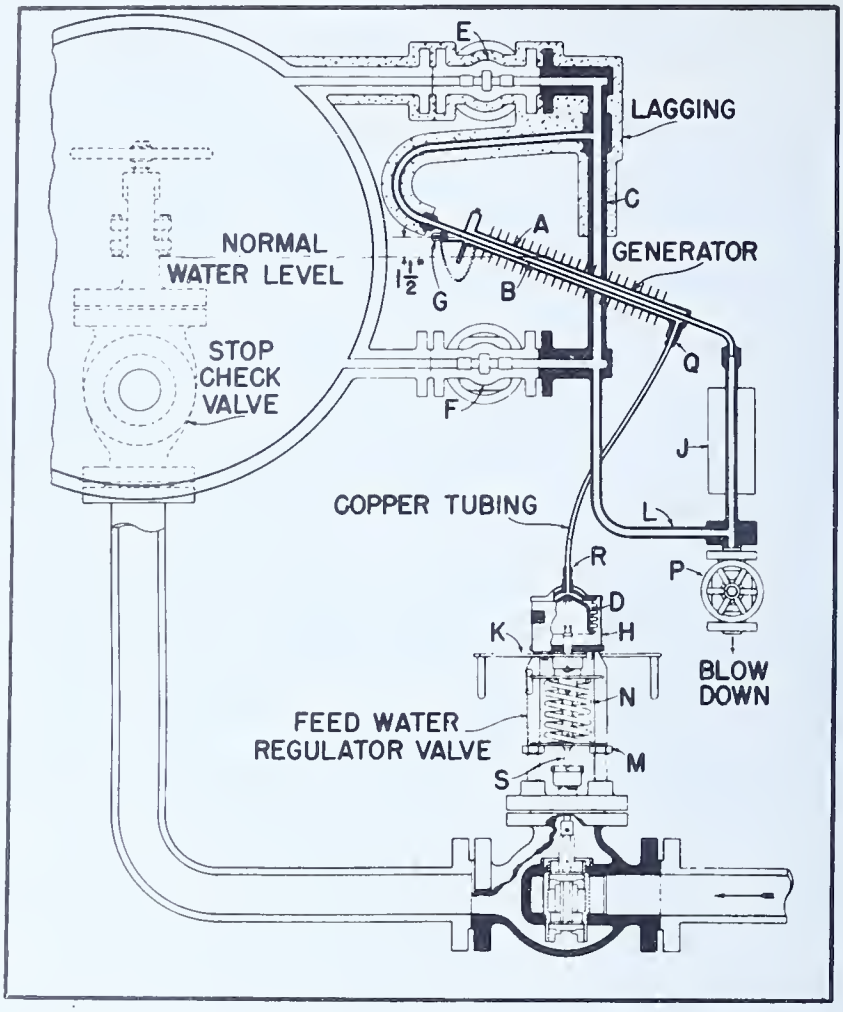


Fig. 255--Principle of Operation of Bailey Feed Water Regulator

13. Open valves E and F, and blow down generator by opening valve
14. After generator has had time to cool off, regulator is rea for service.

How to Fill Generator When Valve is Below Generator

15. If practical, remove bellows and tubing to an elevation high than the generator, and follow same procedure, as when valve above the generator. If not, jack valve open, remove tubi R, and proceed as follows:
16. Remove bellows from valve, and insert in bucket full of wate
17. Compress bellows many times with open end up until all the a is removed and bellows is filled with water.
18. Place end of copper tubing Q in another bucket of water, a draw on end of copper tubing R until syphon is started.
19. Place end of tubing R in bucket with bellows, and allow wat to flow until all air has been washed out of tubing.

20. Stop flow of water by holding finger over end of tubing Q, and at the same time place guard H over bellows and connect end of tubing R to bellows. *Make sure that end of tubing and bellows are completely submerged during this operation so that no air gets into system.*

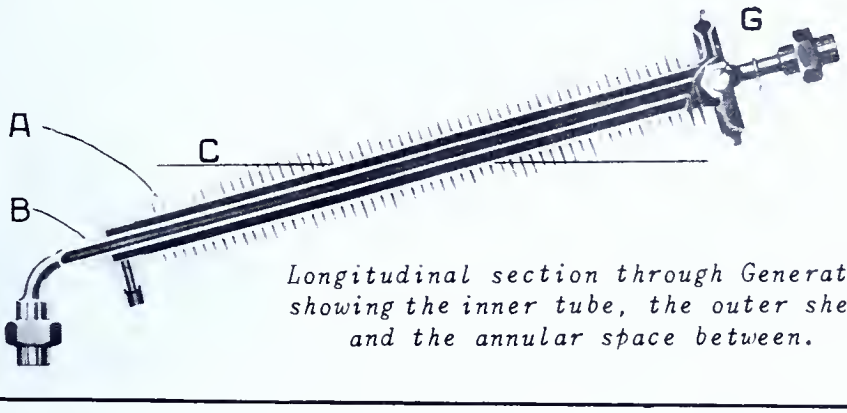
21. Replace Guard H and bellows on valve.

22. Connect end of tubing Q to generator.

23. Remove plug G from generator, and fill generator with water until it overflows at plug.

24. Release handjack K, and allow excess water to run out.

25. Replace plug G and make sure that connections at both ends of tubing, as well as plug G, are made up tight.



Longitudinal section through Generator showing the inner tube, the outer shell and the annular space between.

Fig. 256

26. Open valves E and F, and blow down generator by opening valve P.

27. After generator has had time to cool off, regulator is ready for service.

28. Generator should be blown down periodically; once in 24 hours is good practice. Also generator should be blown down whenever regulator is placed in service after the boiler has been out of service.

29. Spring tension on regulating valve has been adjusted at factory so that valve begins to open when a pressure of 35 pounds per square inch is applied to the metal bellows. This adjustment should not be changed.

30. Do not make up packing nut tight enough to jam valve stem. Make up only finger-tight.

31. Make sure there is no excessive friction or rubbing of regulating valve parts. A mixture of graphite and oil applied to guides and valve stem is helpful.

32. The water level carried by regulator is determined by location of generator. As will be noted from a curve, the relation between water level and valve travel varies with changes in the

boiler pressure. It may be necessary, therefore, to lower the level of generator with respect to normal boiler water level for higher pressure, and to raise it for lower presses. Under average conditions, generator filling plug is located 1 to 1-1/2 inches above normal water level. When deciding on a generator location, it is well to estimate the gauge glass level which will result when the valve is in a closed position. This may be done by following boiler pressure line to the left-hand edge of curve, and by reading the distance in inches between this intersection and the proposed line of normal gauge glass level which will be somewhere below the level of the generator filling plug.

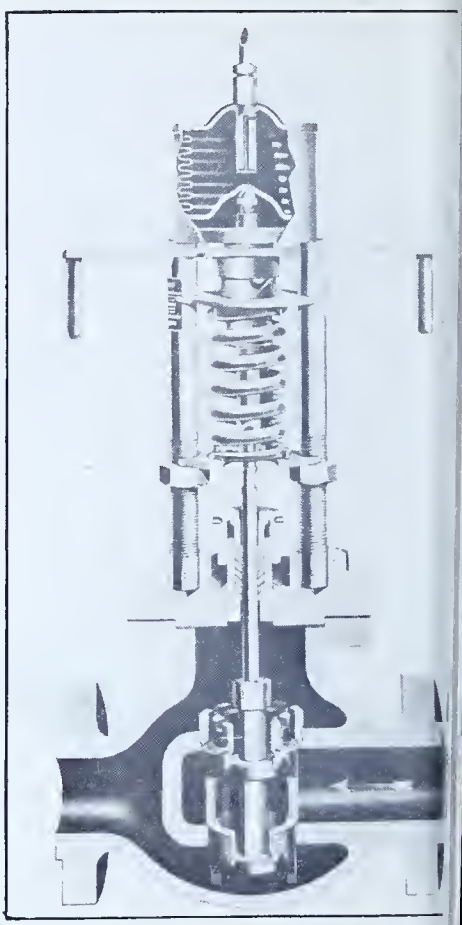


Fig. 257 - Section through Ba ey Feed Water Regulator Val

33. If regulating valve closes completely at too low a water level, this indicates that too little water is in the system and that the system should be refilled.

34. If regulating valve does not close completely until water level gets too high, there is too much water in system and a small amount should be allowed to drain out.

35. Water level carried by regulator under normal load conditi is determined largely by excess of feed-water pressure. creasing feed-water pressure raises water level, and decre ing feed-water pressure lowers water level. Best results w be obtained if the excess pressure shown on the valve d sheet is maintained.

36. If regulator carries a gradually lower and lower water lev this indicates a leak in system. If leak is not apparent, a teaspoonful of borax in water and refill. After regulator run for several hours, a grayish mark will appear at point leakage.

37. Never paint generator or radiator J.

38. Regulator should operate indefinitely without adding water generator.

39. When it is necessary to add water, close valves F and E open valve P. After generator has cooled, remove plug G

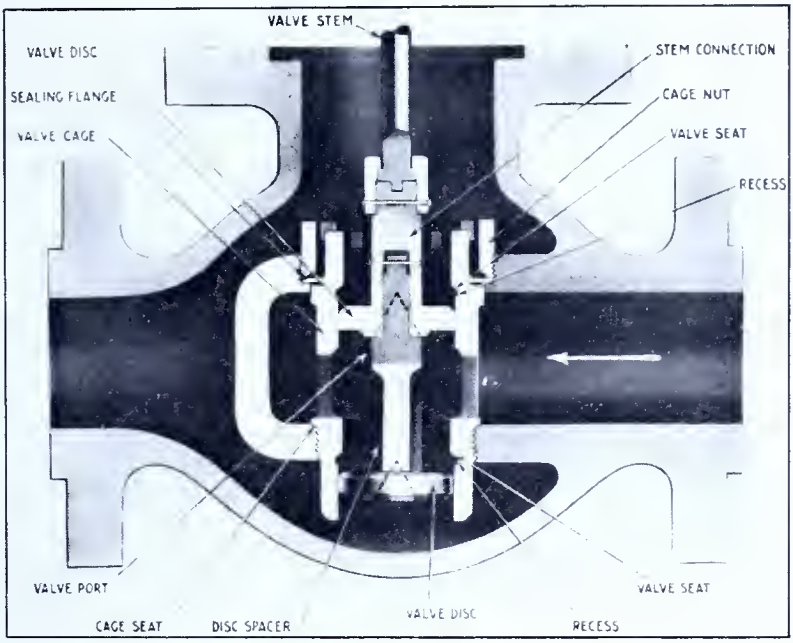


Fig. 258 - Section through Bailey Feed Water Valve Body showing construction of Tight Seating Inner Valve.

add water to overflowing. Make sure the valve is in closed position when this is done.

40. If there is air in system, completely refill in accordance with previous instructions. (Paragraphs 1 to 14 or Paragraphs 15 to 27.)

Installing Winches

RIPTION OF WINCHES

A winch is a mechanically operated device which, by means of a ial arrangement of gearing and drums, pulls a rope, a cable, or a n at various speeds. (Fig. 259.) These ropes, cables, or chains may ttached to the ship's cargo booms, docking hawsers, or anchors.

The winch mechanism is usually steam-operated.

The operator usually controls the winch by means of throttle and e mechanisms. The controls are shown clearly in subsequent illus- ions.

The drums, or capstans, which are fastened to the drive-shaft ex- ions are correctly sloped to fit the ropes, or cables, that may be ped around the drums. See Fig. 259. The small drum "t", Fig. 259, rooved to receive a wire cable. This drum and the drum on the port are sometimes used for emergency steering. When the power is ied to the winch, the rope or cable winds up, and a pull will be ted upon whatever is fastened to the other end of the rope. The ct on the other end of the rope will have a tendency to move toward winch.

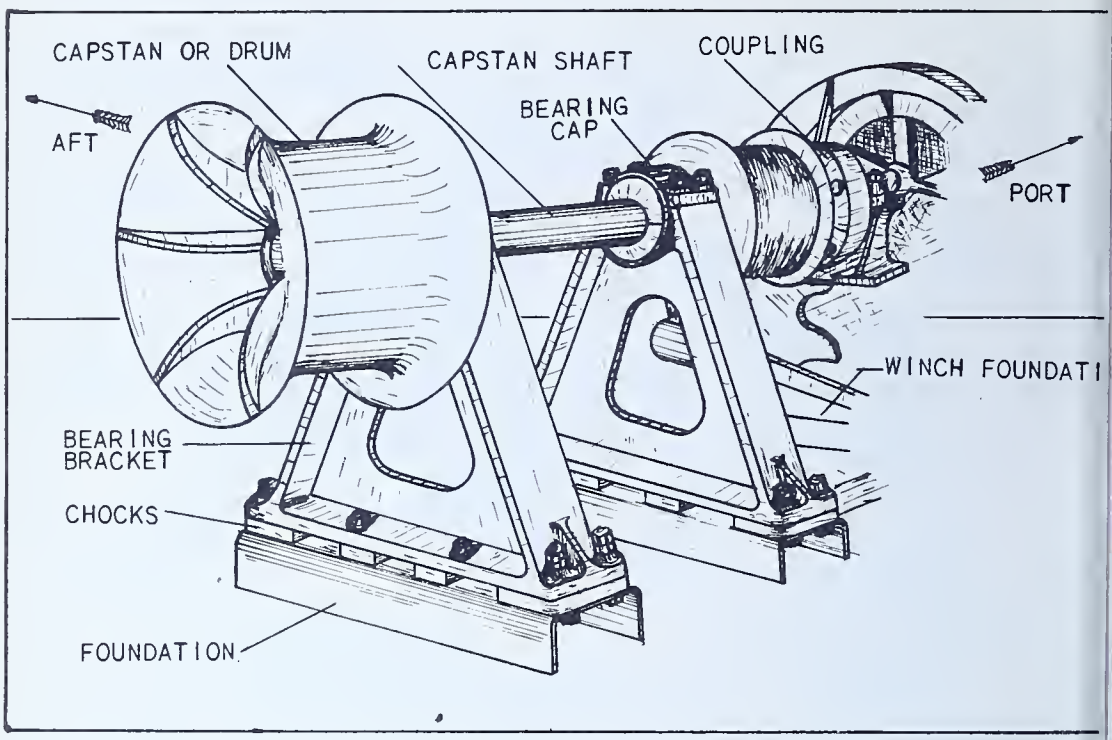


Fig. 259--Starboard Side of After Deck Winch

CLASSIFICATION OF WINCHES

Winches are classified according to their use or location. anchor winch (Fig. 260), used to raise the anchor, is located wit a reasonable distance of the anchor. A stern mooring winch, located the stern, is used to take on mooring lines. Deck cargo winches located amidships and on forward decks. As the name implies, ca winches are used to load and unload cargoes.

Winches are often used for purposes other than those for which t were originally intended; for example, a cargo winch located amidsh might conveniently be used as a mooring winch, fore, aft, or outboa This use is made possible by means of blocks and rollers over which rope or cable applies its pull in a change of direction.

A WINCH SETTING

Some winches are set on special foundations; others can be set the foundation or skid just as built by the manufacturer. All sett up and securing of a winch on the foundation must be done in a man that will not warp or bind the working parts of the mechanism. For t reason the locations for the bearing brackets must all be laid out ca fully to the center lines, as shown on the blueprint. A typical bea bracket is shown in Fig. 261.

The bolt holes for the bracket feet are easily drilled from the side of the bracket, straight down through the channel filler or ba See "a", Fig. 261. All bracket feet are not the same in this respec

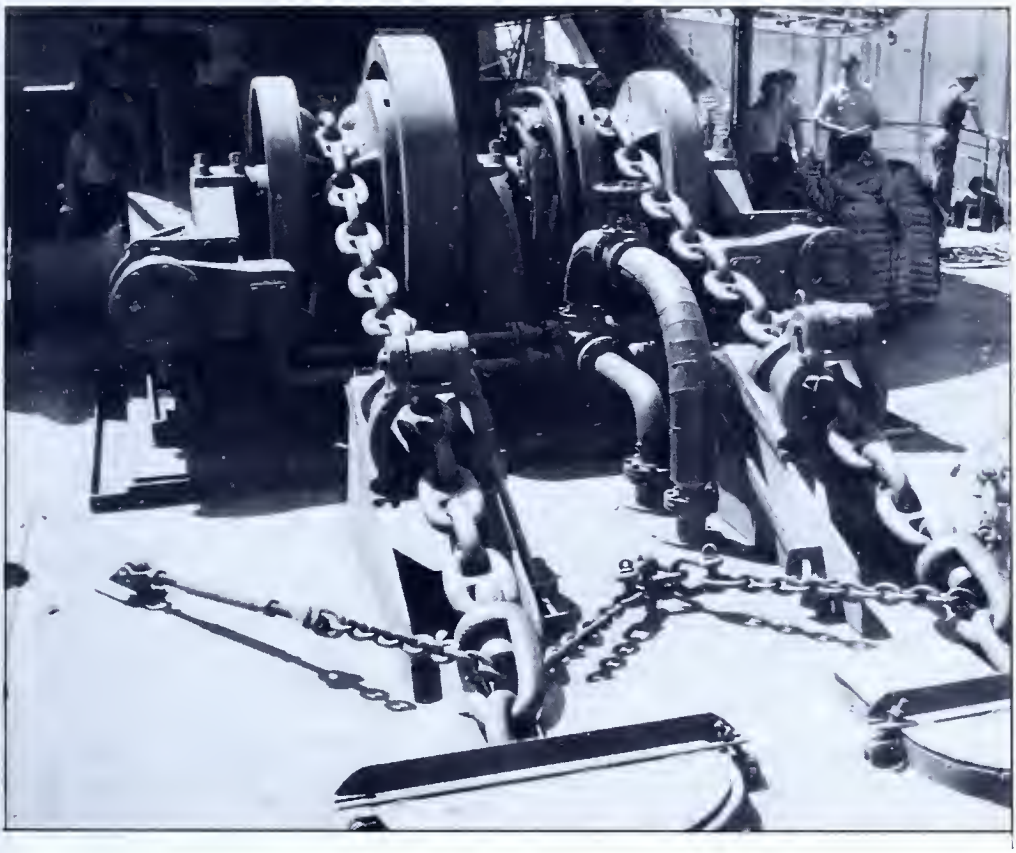


Fig. 260--Typical Anchor Winch on Forward Deck

An example of another type of bearing bracket is shown in Fig. 262. oice that in this case the bolt hole is located under the sloping flange fthe bearing bracket at "b". The bolt holes for the feet cannot be rlled through while the bearing bracket is in position.

TING AN ANCHOR WINCH

The location for an anchor winch is ad off by the shipfitters. Flat bar scorrectly placed and welded to the ek so as to form a band around the ich foundation area. Flat bar is lo correctly placed and welded to h deck around the chain locker bell oths. See Fig. 264.

The ship carpenters build a wooden ondation inside of the band area pn which the winch is to be bolted on.

The setting of an afterdeck winch ifers in some respects from the set-ig of an anchor winch and will be ex-lined fully under the heading, "Set-ig a Deck Winch".

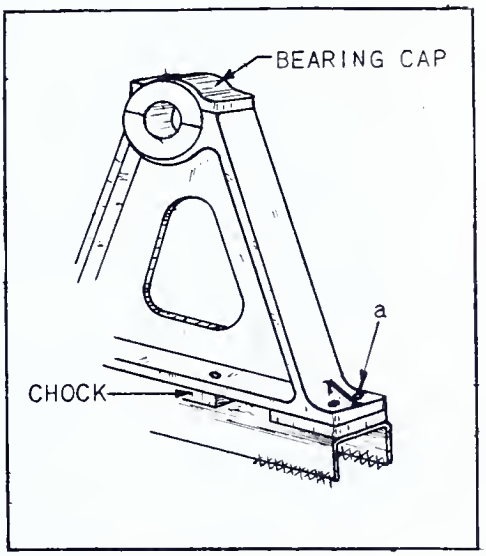


Fig. 261--Bearing Bracket

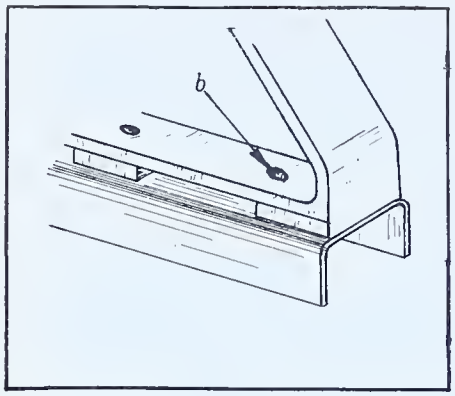


Fig. 262--Bearing Bracket with Inside Bolt Holes

TOOLS AND EQUIPMENT

1. Number 4 corner air-drilling machine
2. Drills
   a. 1 full-length
   b. 1 half-length
   c. 1 12" extension
   (the sizes of the drills depend on the holes in the base of the winch)
3. Shipfitter's taper reamer (bolt-hole size)
4. Chalk line
5. Center punch
6. Full set of wrenches
7. $1\frac{3}{4}$-lb. hammer
8. 6' tape
9. 50' tape
10. Pocket knife

MATERIALS

2 round steel bars 18" long
(These bars must fit the hole in the winch base easily, but snugly.
Red lead
Tarred felt

Tacks	Grommets
Studs	Washers
Nuts	

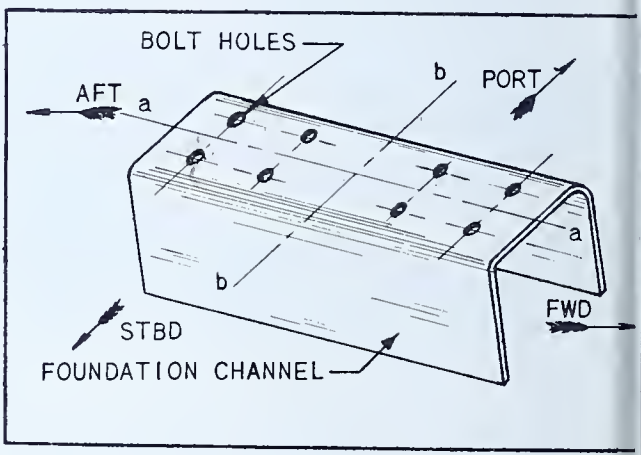


Fig. 263--Bolt Holes Laid Out

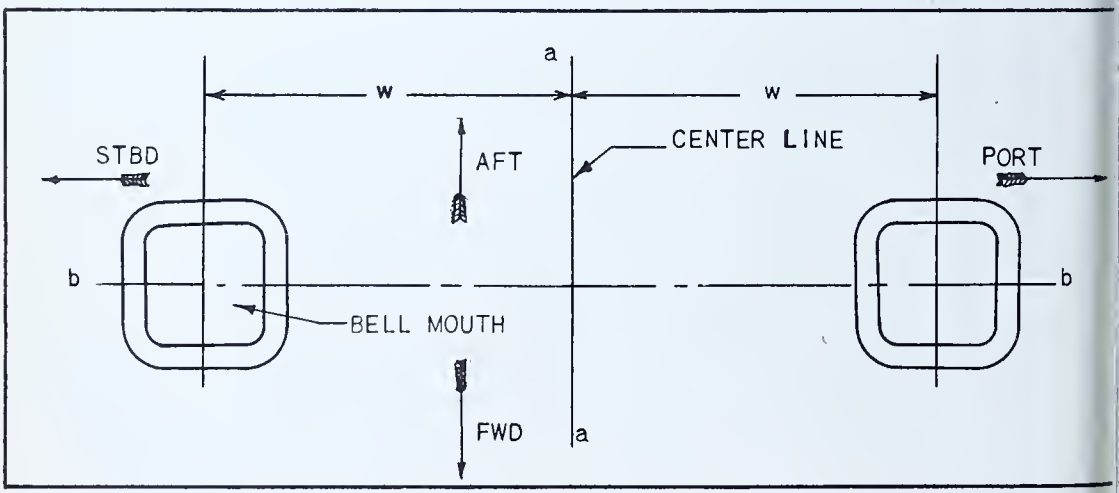


Fig. 264--Layout for Chainlocker Bell Mouths

The job of setting an anchor winch may be outlined as follows:

CEDURE

1. Find the center between the two chain-locker bell-mouths in the deck.
2. Snap a chalk line "a-a" fore and aft on the wood foundation, parallel with the center line of the ship, and passing through the center between the chain-locker bell-mouths in the deck. See Fig. 264. *Distance "W-W" is the same length.*
3. Snap a second center line "b-b" at right angles to center line through port to starboard centers of the chain locker openings.
4. Locate a fore-and-aft center line on the base of the winch. Measure from port to starboard on the base of the winch, find the center of the base, and center punch mark the edge of the base. Do this fore and aft.

   NOTE: There are openings in the winch base, port and starboard, through which the anchor chains fall so that they may be stowed in the chain lockers below decks. These openings must line up with the chain-locker openings in the deck. The outboard edges of the winch base must be marked with a center punch so that the centers of the openings in the base can be set exactly over the line which was snapped on the foundation in step 3.

5. Measure the distance from the forward edge of the winch base to the center of the chain opening in the base.
6. Lay off this distance on the outboard edges of the winch base and mark with center punch.

   NOTE: These center line marks on the winch base must correspond with the chalk line which was snapped on the wood foundation.

7. Have the winch set by the riggers.

   NOTE: The ship riggers set the winch on this foundation under the supervision of the outside-machinist leader.

8. After the winch has been set by the riggers, go below into the chain locker and inspect the alignment of the winch-chain holes with the chain-locker openings. The centers when checked are equal fore and aft and port and starboard. Adjust the winch if necessary.
9. When the winch has been adjusted to the proper location on the foundation, have the carpenters inspect the wood foundation.

   NOTE: At this point the ship carpenter checks the fit between the base of the winch and the wood foundation for high spots.

10. Drill all bolt holes, using the holes in the base of the winch as a guide. The holes are drilled through the wood foundation and through the steel deck. Check carefully when drilling to make sure that there are no electric cables immediately beneath the holes. Consult the leader if there are obstructions.

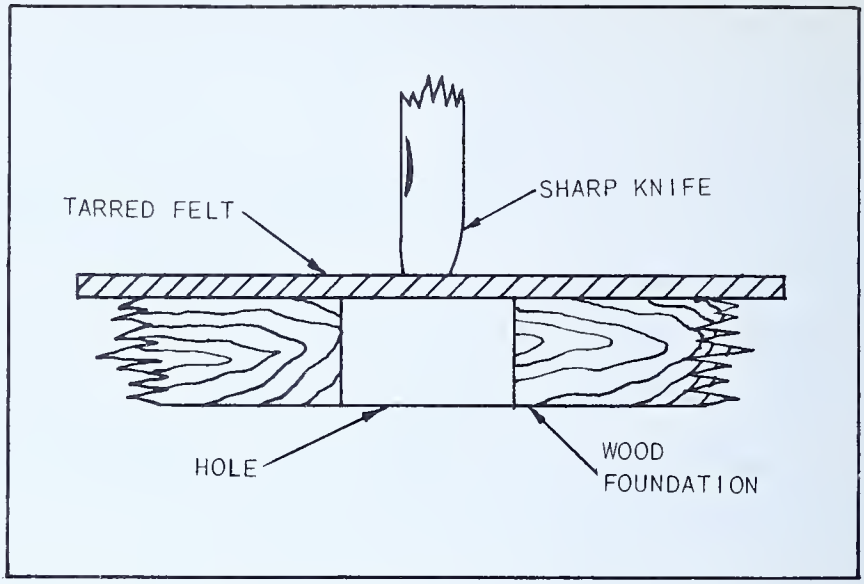


Fig. 265--Cutting the Tarred Felt Around the Bolt Holes

11. Mark through all holes that cannot be drilled through the of the winch.

    NOTE: Some parts of the base are heavier than others. W the thickness does not exceed four or five inches, hole locations may be marked with a pencil. Where thickness runs perhaps as much as ten inches, a d is inserted through the hole in the base and the is "spotted". All the holes should have been dri or spotted at this point.

12. The riggers lift the winch off the foundation, and the h that could not be drilled before are drilled now, using "spotted" points to start the drill.

    NOTE: The carpenter trims off the high spots of the woo this time to insure a good fit between the wood f dation and the winch base.

13. After all the holes are drilled, paint and soak the wood red lead.

14. Cover the wood foundation surface with tarred felt, and it down securely with number ten tacks. Special attentio given to tacking the corner of each sheet of tarred f (These tarred felt sheets come in rectangular pieces 2' x 1/8" thick.)

15. Cut holes through the felt to match the bolt holes bore the foundation.

    NOTE: Find the location of each hole with the fingers, and through the felt with a sharp knife. Follow the sid the hole in the wood foundation, and trim the felt f as large as the hole. See Fig. 265.

16. Have two round steel bars at hand. (See materials)

17. Soak the entire felt surface with red lead.

18. Have the riggers lift the winch and swing it over the foundation. Lower to within three inches of the painted surface.

19. Insert each one of the steel bars in opposite corners of the winch base through an "open hole".

    NOTE: "Open hole" means a hole that is so located that the bar may be easily removed after the winch is set on the foundation.

20. Swing the winch until the hole through which the steel bars are inserted correspond with matching holes in the foundation, and enter the bars in the foundation holes.

21. Lower the winch. The steel bars guide the winch to the correct setting.

22. Remove the steel bars.

23. Number each hole in the base of the winch.

    NOTE: Start numbering the holes at the port side forward; proceed aft and all around the winch base to the starting point.

24. Measure the length of the bolts required for each numbered hole, and list the sizes on a convenient scratch pad.

    NOTE: Measure each hole from the top of the base to the underside of the deck. To this dimension add sufficient length to allow for a nut and a half-nut on the top of the base; allow for a grommet, washer, and nut below deck. (For example: a bolt 1-1/2" in diameter requires 2-1/2" on top and 1-3/4" below. If the "metal to metal" length measures 8", then the total length of the bolt will be 8" 2-1/2" 1-3/4" 12-1/4".) The leader, however, usually checks for the bolt length. There must be 1/2" more thread on the respective bolt ends than is required for the thickness of the nuts.

25. Order studs from the machine shop. These studs are made of special steel.

26. Go below deck, and with the corner air-drilling machine ream all the bolt holes in order to take care of misalignment and clear the holes of slivers.

27. Install all the studs beginning at the inboard holes. Tighten each stud reasonably tight. Check with the leader.

28. Have the entire job inspected.

ETTING AN AFTERDECK WINCH

An afterdeck winch is located on the poop deck aft of the galley. he outside machinist bolts the foundation angles to the base of the eck winch according to the blueprint. Shipfitters lay out the location or the winch and then set it. The shipfitters tack weld to the deck nd then brace the angles which the outside machinist bolted to the inch base. The winch is then lifted from the angles, and the foundaion is completed by the shipfitters; brackets and struts are welded n place to stiffen and make the foundation solid.

When the shipfitters have completed the foundation, the outsi machinist levels off the surface of the winch base. The painters a then notified to apply a coat of suitable protective paint. The found tion is now ready for the setting of the winch.

CAPSTAN SHAFTS

This type of winch is equipped with capstan shafts that extend so distance beyond the winch. Port and starboard couplings connect t capstan shaft to the main driving shaft. These shafts may extend f as much as 4 feet and are supported port and starboard by one or mo bearing pedestals. The bearing pedestals (called bearing bracket are set to carry the capstan shaft in correct alignment with the ma driving shaft. Suitable foundations are placed under the feet of t bearing pedestal, and they are welded to the deck. Bearing bracke are bolted to these foundations with fitted chocks between foundatio and pedestal feet. See Figs. 262, 266 and 271.

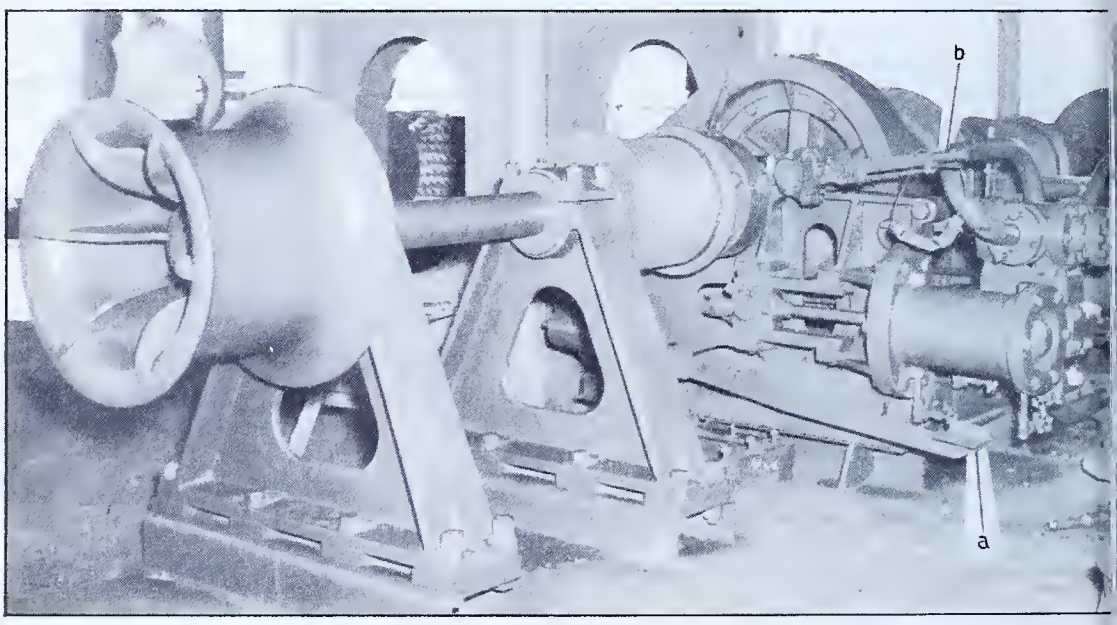


Fig. 266--After Deck Winch Showing Controls

Figure 266 shows the starboard side of an afterdeck winch. T foot pedal "a" controls the brake. The hand lever "b" controls the moti power. The foundations are formed in the blacksmith shop. A flat pla approximately 1/2" thick, and of the correct size, is heated and be to the channel shape shown in Fig. 263. The flat top of the foundati is then planed off level and true in the machine shop. It is on th machined surface that the locations for the bracket feet are laid ou In Fig. 263 are shown center lines which indicate the center of t foundation lengthwise and crosswise, and the centers of the bolt hole

LS AND EQUIPMENT

1. Portable grinder
2. 8" outside calipers
3. 8" inside calipers
4. Full set of wrenches
5. Drills (diameter of the drill depends on the diameter of the bolt holes in the winch base and brackets)
6. Shipfitter's taper reamer (bolt-hole size)
7. Center punch
8. 1-3/4 lb. hammer
9. 6' tape
10. 50' tape
11. 14" second-cut flat file
12. No. 4 corner air-drilling machine
13. 14" square bastard file
14. Thickness gauge
15. C-clamps
16. Scriber
17. Dividers
18. Oilstone
19. Spoon-bearing scraper
20. Hermaphrodites

MATERIAL

Garlock packing
Chalk
Bolts
Nuts
Washers
Piece of 1-1/16" round stock 6" long

The job of setting an afterdeck winch may be outlined as follows:

CEDURE

1. Procure from the shipfitter the side angles upon which the winch is to be set.
2. Block up the winch about one foot high all around.
3. Chalk one leg of each side angle for the entire length and clamp the chalked side to the winch base in a fore-and-aft position, one angle to port and one angle to starboard; place the legs of the angles inboard with the edges of the angles extending beyond the winch base about 1/2". See Fig. 267. The ends of the angles project beyond the winch base about 1-1/2" fore and aft. Divide the distance so that the angles project the same amount fore and aft, even if the distance is more or less than 1-1/2".

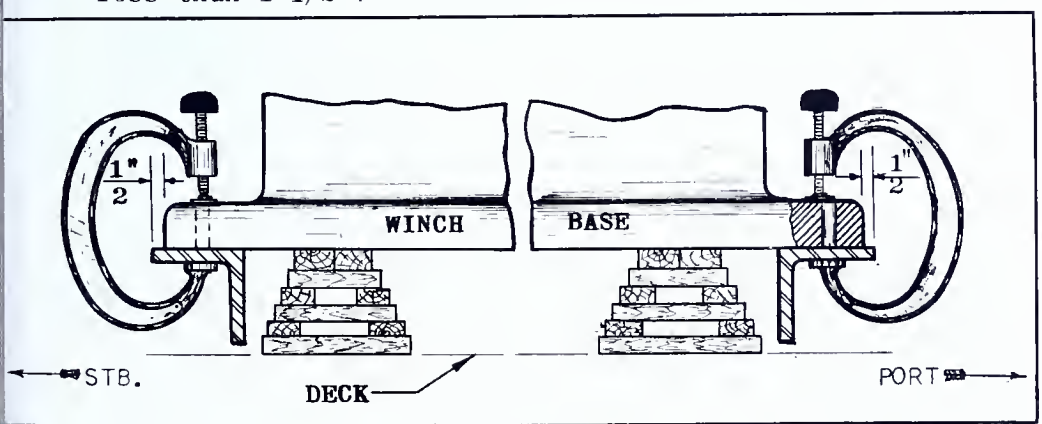


Fig. 267—Winch Base Blocked Up for Placing Side Angles

4. Scribe through the holes in the winch base, and mark the l tions of these holes on the angles.

   NOTE: Scribing the hole locations must be done very caref because there is no room to use a reamer to line up holes after they are drilled.

5. Mark the angles on one end, and place a similar mark on winch base above the angles (make the mark with the ce punch). This will enable the mechanic to replace the an in the correct location.

6. Remove the angles, and make four similar punch marks, spaced equally around the circumference of each bolt hold circle. See Fig. 268.

7. With the dividers, find the center of the scribed circle. See Fig. 82 "Removing Broken Studs and Bolts", Part I, for method of procedure.

8. Center punch the center at the intersection of the divider lines.

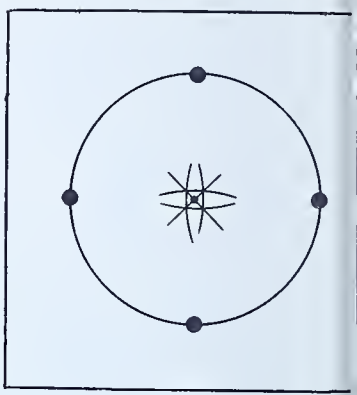


Fig. 268--Marking Bol Hole Centers

9. Drill a 3/8" pilot hole through all centers. See Part I, "Reaming Through Holes", Fig. 64, for pilot-hole procedure.

10. Select a drill of the same diameter as the hole in the w base, and drill through the pilot hole.

11. Measure for the bolt lengths, and allow for a nut, plus beyond the actual thickness of winch base and angle.

12. Check for the proper angle location (See step 5), and the angles to the winch base.

    NOTE: The shipfitters have laid out the location of the w on the poop deck.

13. Have the ship riggers lift and place the winch on the previ laid out location on the deck.

14. Have the shipfitter level the winch and weld the angle ed the deck. The outside machinist leader checks the job correct installation at this point.

15. Remove the bolts, and lift the winch off the foundation so the foundation may be finished by the shipfitters.

    NOTE: The shipfitter welds gussets, angles, and cross plat position to stiffen the foundation.

16. Grind off the top of the foundation all welding burrs w might interfere with the level fit between the winch base the foundation top.

17. Notify the painter, and have the foundation painted with rust solution.

18. Set the winch back on the foundation. Bolt securely, and all bolts with 1/2" nuts.

19. Remove the fitted bolts from the main drive shaft of the winch, and clean the bearing surface. Check for and remove any rough spots with the oilstone.

NOTE: To avoid losing the fitted bolts, wire them together and wire the bundle to the winch.

20. Check the number which is stamped on the main shaft coupling, and find the matching number on the capstan shaft coupling.

21. Have the riggers block up the capstan. When this operation is complete, line up the capstan as close as possible with the main drive shaft. The capstan should be blocked with two wooden wedges to prevent it from shifting.

NOTE: The inboard end of the capstan shaft is held temporarily by the spigot coupling. One bolt is placed loosely through the coupling to prevent slipping. See Fig. 270.

22. Lay out center lines on the top of the channel foundation as shown in Fig. 263.

23. Locate the center of the bearing bracket on the edge of the base, fore and aft, port and starboard. Center punch these centers. See "x" and "y", Fig. 271.

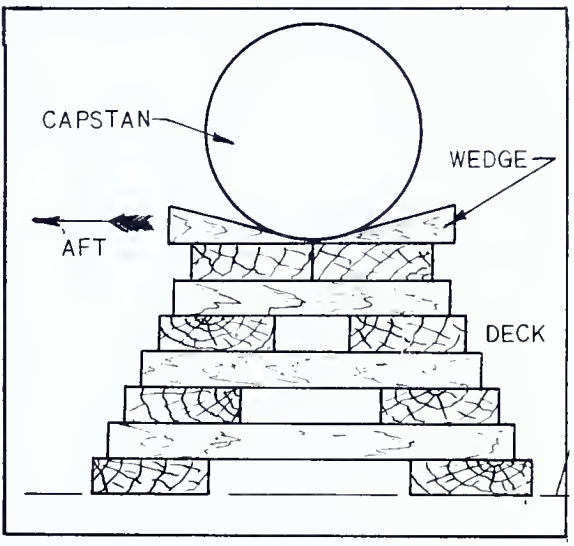
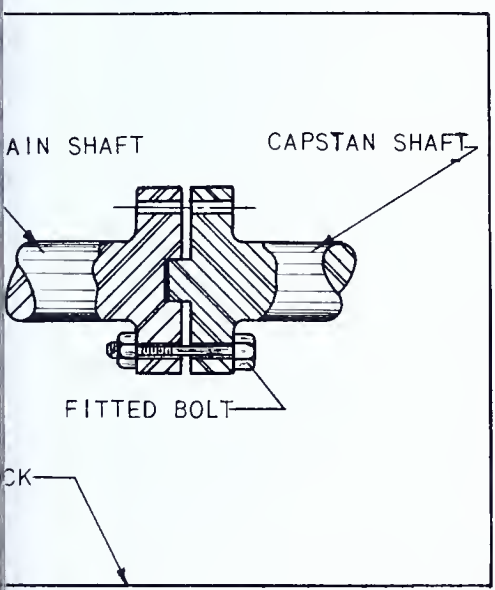


Fig. 269--Blocking the Capstan



g. 270--Spigot Coupling Support

24. Place the bearing-bracket center on the channel foundation center. Center the bracket on the channel foundation fore and aft, port and starboard, to match the center-punch mark and the center lines.

NOTE: Chalk the machined surface of the channel foundation so that the "lay out" lines will stand out clearly.

25. Scribe through the holes in the bearing bracket. Mark the foundations and the base of the bearing bracket so that the locations will not be lost.

26. Center punch the circumferences of the holes as in step 6, and locate center as in step 7.

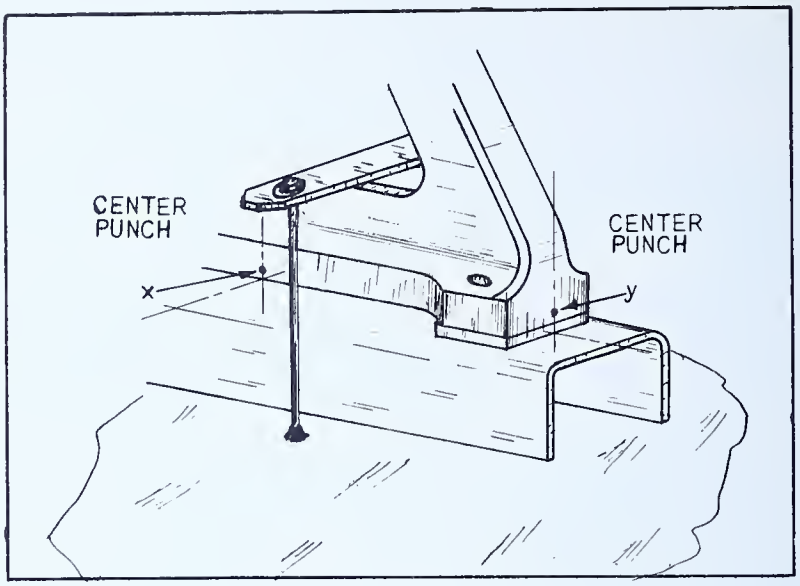


Fig. 271--Marking the Bearing Bracket Centers

27. Center punch mark at the intersections of the divider lines.
28. Drill 3/8" pilot holes through the centers.
29. Select a drill of the same size as the diameter of the hole the bearing-bracket base, and drill pilot holes through.
30. Clean up the machined bearing surface on the capstan shafts, stone any rough spots.
31. Remove the cap from the bearing bracket, and clean any ro surfaces carefully.
32. Apply grease to the shaft-bearing surfaces.
33. Slide the bottom half of the bearing bracket on the shaft, block up temporarily.
34. Place a piece of garlock packing at the top side of the sh on the bearing surface. This packing should be the width the bearing and about 1/3 of the shaft circumference in len

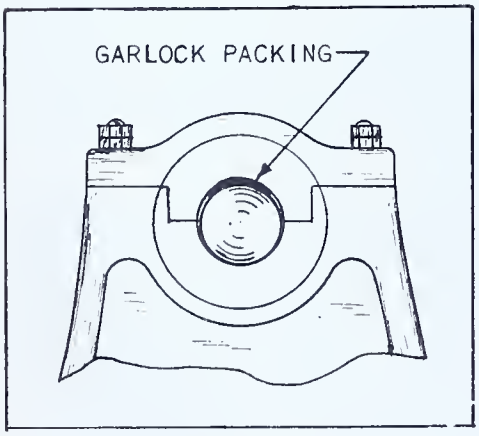


Fig. 272--Placing Garlock Packing

35. Replace the base cap on the bear bracket over the garlock packing.
36. Bump the bearing bracket out to capstan hub to clear the shaft of hub about .030 of an inch.
37. Tighten the bearing cap on the g lock packing so as to draw the bot half of the bearing bracket tight the shaft. See Fig. 272.
38. Check the coupling between the m drive shaft and the capstan sha The bottom of the coupling should lined up at the bottom .003 "ope and about .015 between the faces the couplings. See Fig. 273.

39. Check the marks on the foundation with the marks on the bearing bracket, and slide the correct foundation under the bracket. If the foundation is too high to set, have it rough-burned off until it will slide under easily.

40. Bolt the foundation to the bottom of the bracket with temporary bolts. Draw the bolts up tight.

41. Chalk the foundation about 1" above the deck on both sides for the entire length.

42. Re-check the coupling for clearance as shown in Fig. 273.

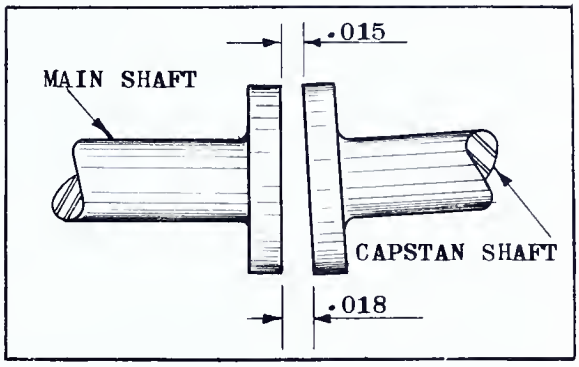


Fig. 273--Coupling Face Allowance

43. Measure with the square, and level the foundation with the deck fore and aft.

44. Set the "morphs" to 1", and scribe on the chalked surfaces parallel lines on both sides of the foundation.

45. Remove the bolts, and remove the foundation.

46. Center punch mark the foundation along the scribed lines on both sides 1-1/2" apart.

47. Have the foundation burned off to these center-punched lines.

48. Knock off the slag and rough sides of the burned edges with a hammer.

49. Slide the foundation back to the former position under the bracket, but on the deck, leaving a 1" space between the top of the foundation and the bottom of the bracket.

50. Insert two pieces of round stock, easy bolt-hole size, through the bolt holes in the opposite corners of the bracket base and the holes in the foundation. This operation will serve to line up the foundation holes with the bracket holes.

51. With fox wedges, raise one side of the foundation until it is 1-1/16" higher than the other side, thus forming a wedge-shaped space between the foundation and the bracket base.

52. Re-check the coupling for clearance as in Fig. 273.

53. Have the welders tack all four corners of the foundation to the deck.

54. Re-check the wedge-shaped space as in step 51 to make sure that the foundation is 1/16" higher on one side than it is on the other side.

55. If correct, weld the foundation to the deck inside and outside for the entire length.

56. Place heel wedges between the foundation and the bearing bracket, two forward and two aft. The bracket is now supported on the heel wedges.

57. Remove blocking from under the capstan.

58. Use a piece of scrap metal to make a strongback to lay across the bracket edge. Drill holes for the bolts. Place two bolts long enough to pass through the strongback and reach to the deck. Weld the bottom end of the bolts to the deck. Place nuts and draw down tight. See Fig. 271.

59. Weld a piece of flat bar to the deck aft of bearing bracket about 2". A hole is drilled through the plate bar for a bolt. The bolt is used as a backing screw to prevent the bracket's drifting aft. See Fig. 274.

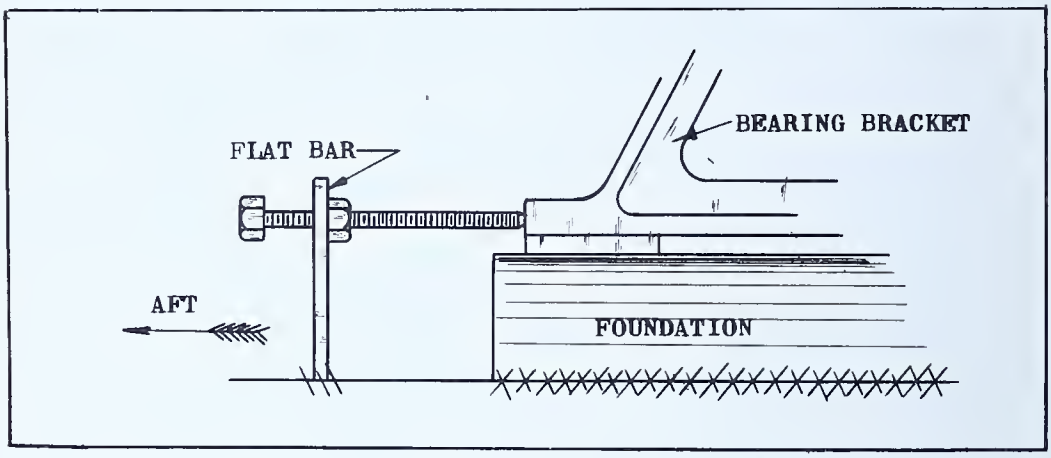


Fig. 274--Using a Flatbar Stop and an Adjusting Screw

60. Check all adjustments for alignment; readjust if necessary.

61. Take chock sizes and order chocks.

62. Fit chocks.

63. Scribe holes in chocks, and have them drilled.

64. Place chocks, install the bolts, and draw down tightly. Loc with the half-nuts.

65. Remove the heel wedges.

NOTE: Repeat on the opposite side of the winch all of the step herein enumerated. Both sides are worked together.

66. Re-check coupling. See Fig. 273. If the alignment is the sam as it was before, have the inspector approve the job. If th coupling is out of alignment, the chocks will have to be re fitted.

67. Drill and install 1/2" dowels on opposite corners of the bear ing brackets. See Fig. 275.

NOTE: The dowels are turned .502 of an inch in diameter an threaded for 3/4 of an inch on one end. The thread i for the purpose of removing the dowel if necessary The dowel must be long enough below the thread to pas through the bracket and the foundation. The threade end of the dowel must be undercut to form a shoulde and the end must be slightly rounded as in Fig. 275 "b".

Run a nut on the threaded end of the dowel flush with the shoulder before starting to drive the dowel into place. This nut will prevent mushrooming the end of the dowel under the hammer when the dowel is driven into place.

Drill the dowel holes with a 31/64" drill. After drilling, ream through with a 1/2" hand reamer. The dowel should drive in with medium force.

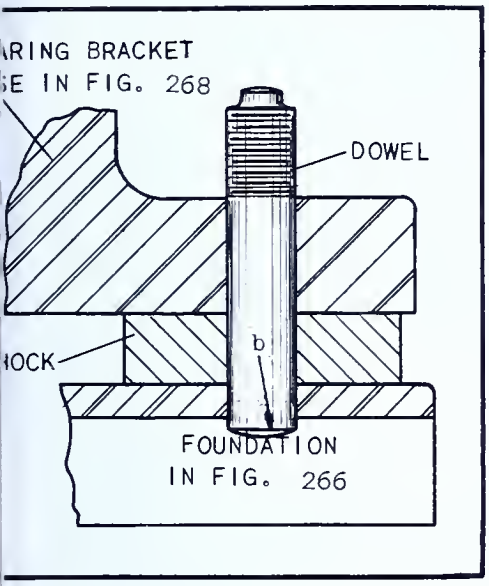


Fig. 275--Drive Fit Dowel

68. Remove the bearing-bracket cap, and take out the garlock packing.

69. Clean out the bearing cap. Clean up the shaft.

70. Grease the shaft, replace the bearing cap, and tighten down.

71. Check with the feelers and allow .012 of an inch clearance between shaft and bearing. If more than .012, remove a shim. If less than .012, add a shim.

72. Clean up feed bolts and coupling.

73. Drive fitted bolts through coupling, and draw all nuts down snugly.

74. Drill and dowel the base of the deck winch on the foundation.

75. Grease the entire mechanism, and prepare it for operation.

nstalling A Steering Gear and Telemotor For Pilot House Indication

ERAL DESCRIPTION OF MAIN STEERING GEAR

The main steering gear controls the position of the ship's rudder. nip's rudder weighs as much as 24 tons and steering the ship by hand is done in a small pleasure boat is not possible.

A mechanically operated device which is known as a steering gear installed in the after peak on a deck called the steering-gear flat. ain motors, pumps, and other mechanisms are installed on the steer--gear flat which control the operations of the steering gear. Con- l wheels are installed in the wheelhouse and on top of the wheel- se. The wheelhouse is located on the navigating bridge deck.

Other control wheels are located on the steering-gear flat forward the main steering gear. The control wheels actuate the steering anisms by means of hydraulic power which is transmitted from control el to steering gear through a pipe line connecting the wheelhouse n the steering-gear room. Hence, the entire installation is known he ship's steering gear. The port side of the forward end of the ering-gear engine is shown in Fig. 276.

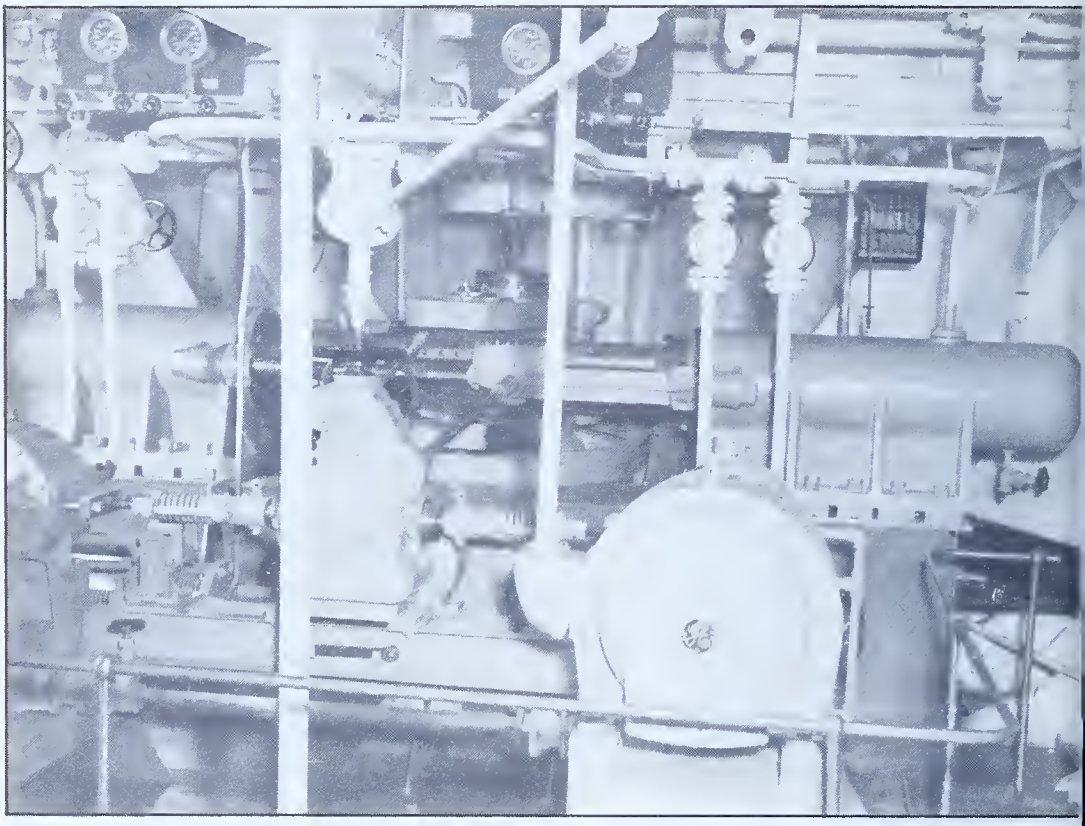


Fig. 276--Port Side of Steering Gear in Steering Gear Room

ALIGNING STEERING GEAR MECHANISMS

The entire steering-gear mechanism is lined up with the center of the rudder stock. Hence, the rudder must be placed and the ru stock installed before the work of installing the steering gear may be

Figure 277 shows the rudder (a), the rudder stock (b), the ru trunk (c), the carrier bearing (d), the bearing disk (e), the carrier brake drum (f), the tiller (g), and the keeper ring (h), installe position. All of these parts must line up with the rudder stock ce line fore and aft, port and starboard.

The procedure for the installation of these parts up to the p where the installation of the steering gear commences is as follows:

1. Weld the rudder trunk (c) in position as shown.
2. The rudder is placed and the gudgeon pins installed as s in Fig. 277 at "z".
3. The rudder is raised and a steel block 2" thick is inse between the upper gudgeon eye and the rudder to hold the ru in this raised position. See Fig. 277 at "x".
4. Install the rudder stock (b).
5. Install the carrier bearing (d).

NOTE: The carrier bearing is bolted to the rudder trunk.

6. Install the bearing disk (e).

7. Install the carrier and brake drum (f), and have the brake hand in position on the brake drum to be connected to the brake lever later.

   NOTE: The two halves of the carrier and brake drum are not tightened snugly until the rudder is lowered into working position.

8. Install the tiller (g).

9. Install the keeper ring (h).

10. Lift the rudder enough to remove the 2" block which was placed to raise the rudder in Step 3.

11. Lower the rudder into position so that the rudder carrier takes the entire weight of the rudder assembly.

12. Tighten the bolts through the two halves of the rudder carrier and brake-drum casting, securing the carrier to the rudder stock.

13. Swing the rudder to port and starboard and check it against the rudder stops for the correct angle with the ship center line. If the angle is not correct, add to or take away from the rudder stops.

14. Bring the rudder to amidship position and secure with chain falls from the tiller to the shell of the ship.

15. Install the packing and the split packing glands shown at "j", Fig. 277.

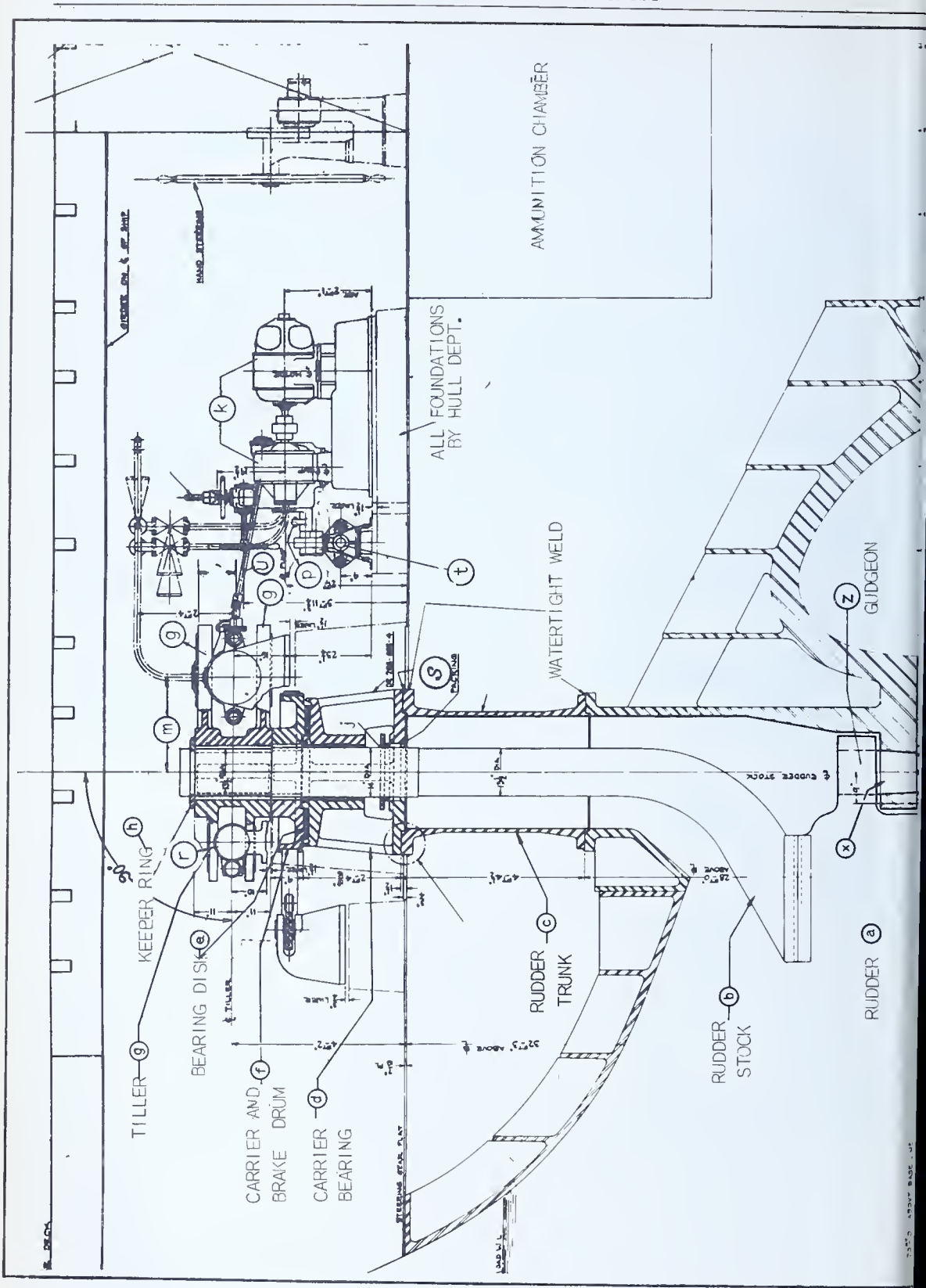
STALLING MAIN STEERING-GEAR RAMS AND CYLINDERS

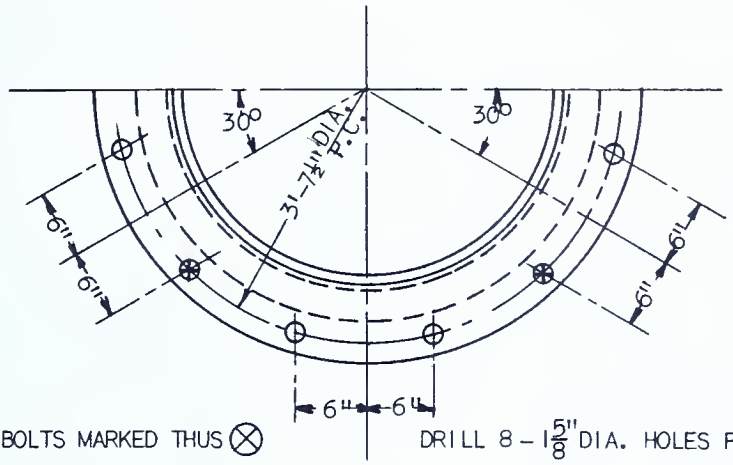
The foundations for the main steering-gear ram and cylinders are " "A" "A", Fig. 279. Figure 281 shows this unit extending athwartships. te the two heavy bolts, "B" "B" which act as a support for the follow- gear bearing and pinion. These bolts are shown at "B", Fig. 280 and "B", Fig. 282. The bolts tie the port and starboard rams and cylinders gether and ensure their correct alignment.

The foundation tops, Fig. 279, "A", "A", "A", are rough-leveled off th a portable grinder and finish-ground with a portable surface grinder. e surfaces of the foundation tops are ground level and smooth for a dis- nce of approximately 10" from the edge, fore and aft. This 10" level ane surface slopes from nothing to the outside about 1/64 of an inch, t not more than 1/32 of an inch. A long straight edge is used to check e amount of slope. See Fig. 287.

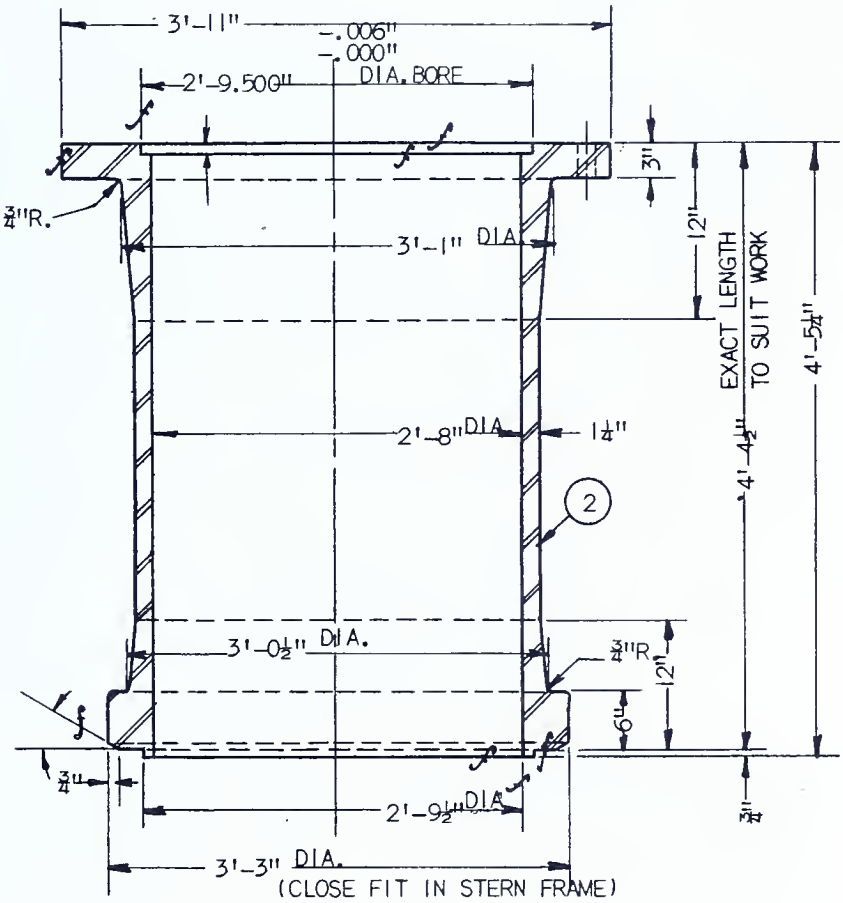
This procedure is carried out on all the foundation tops shown in g. 279, "B"-"B", "C"-"C", "D", "E", "F", and "G".

The shipriggers pick up the main unit and lower it to the foundation " "A". The unit is then leveled and brought to the correct position re and aft, port and starboard. The job is now ready to have the ocks fitted and the bolts installed through the base. This main ram d cylinder unit must be in place before proceeding to install any of e other parts of the steering gear.


AMMUNITION CHAMBER
ALL FOUNDATIONS BY HULL DEPT.
WATERTIGHT WELD
GUDGEON
RUDDER
RUDDER STOCK
RUDDER TRUNK
TILLER
KEEPER RING
BEARING DISK
CARRIER AND BRAKE DRUM
CARRIER BEARING



- 1½" FITTED BOLTS MARKED THUS ⊗ DRILL 8 - 1 5/8" DIA. HOLES FOR 1½" BOLTS



RUBBER TRUNK "C" SHOWN IN FIG. 277

Fig. 278--Cast Steel Rudder Trunk

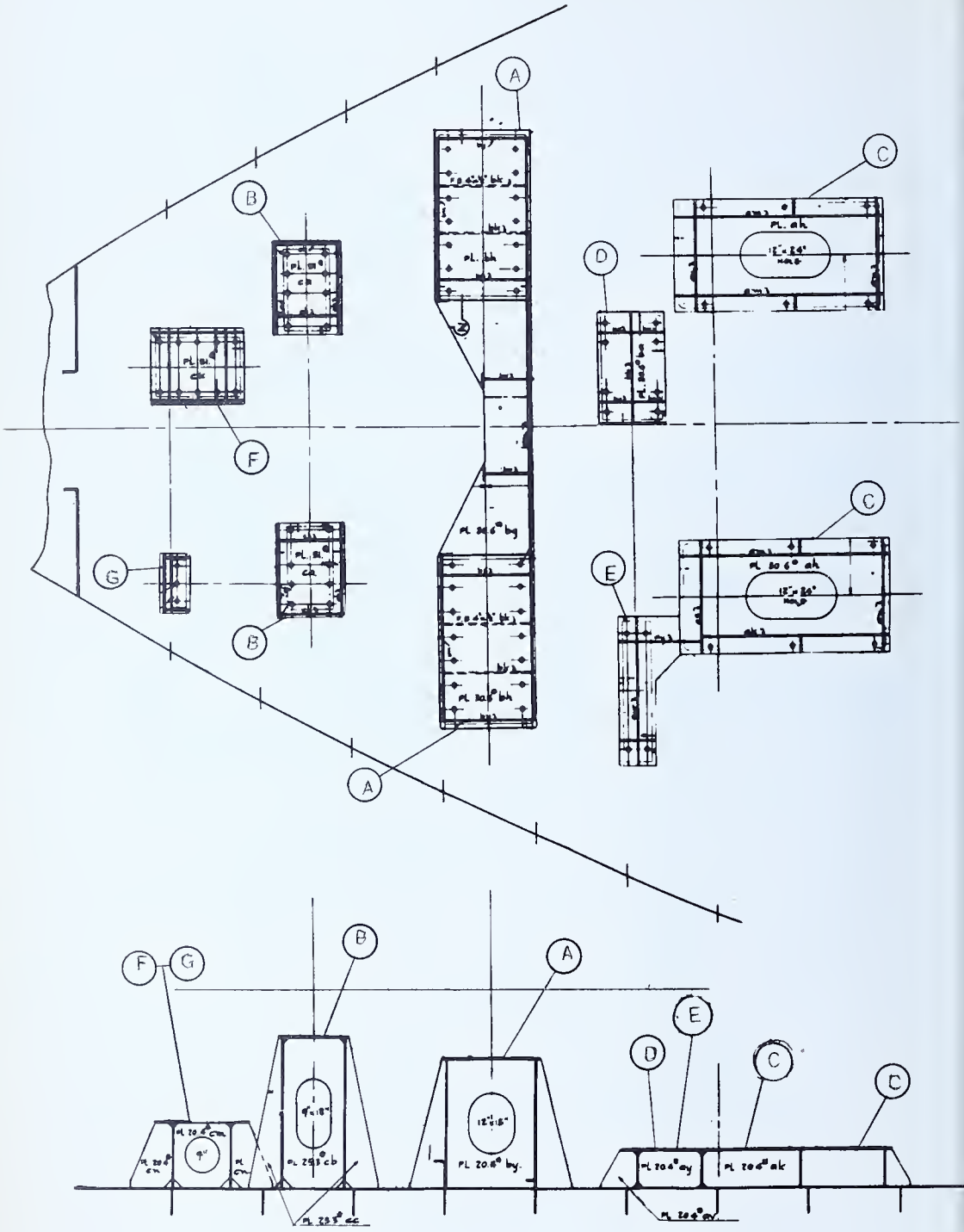


Fig. 279--Foundation Plan for Main Steering-Gear Rams and Cylinders

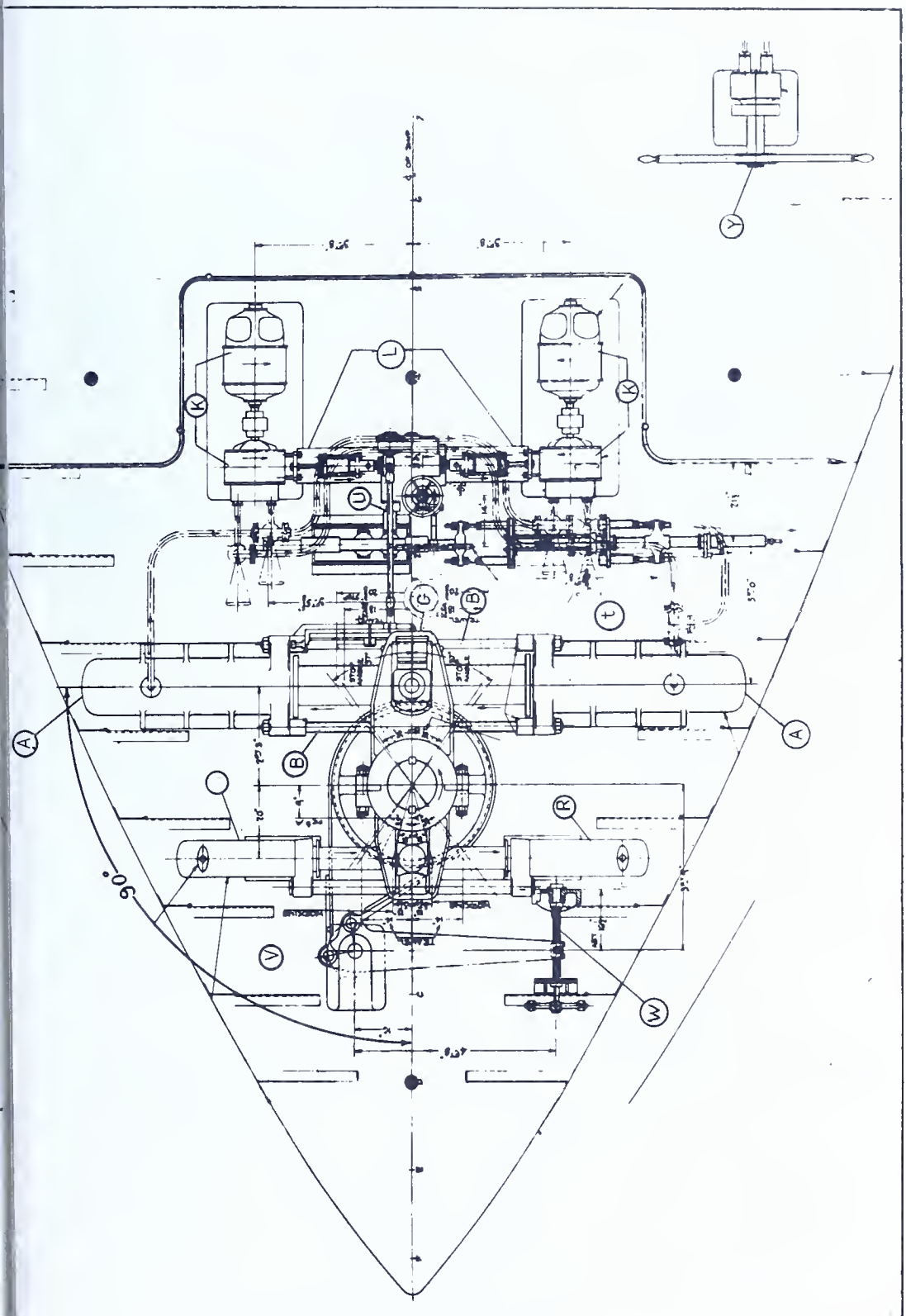
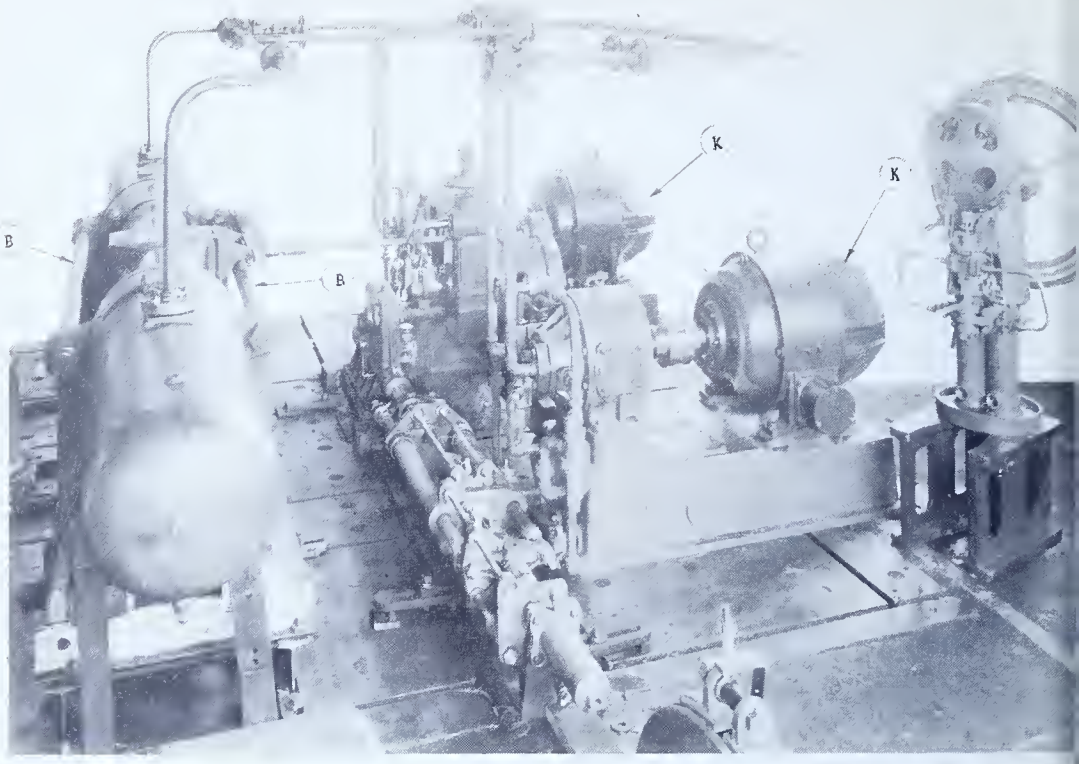


Fig. 280—Plan View of Steering Gear Installed on Steering Gear Flat



Courtesy American Engineer

Fig. 281--Main Steering-Gear Ram and Telemotor

16. Inspect the position of the ram in the cylinders, and mak necessary adjustment to bring the pivot hole in the ram t fore-and-aft center line of the ship.

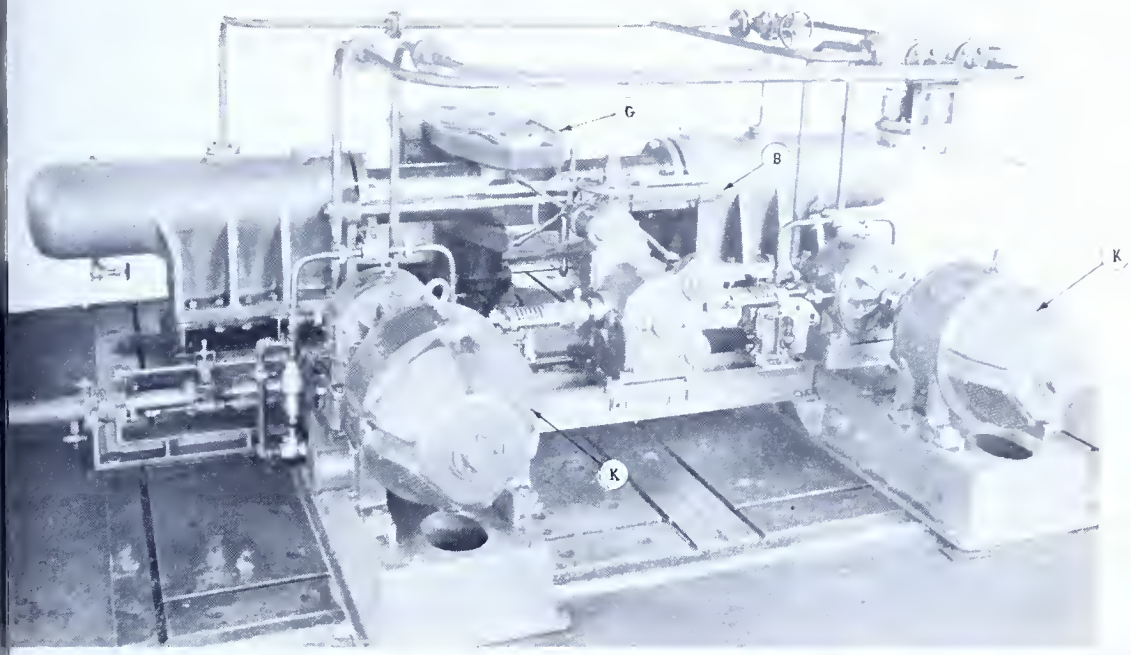
17. Weld angle clips at convenient places to clear the corner positions at points shown at "a", Fig. 286. Complete the ing of angle clips to both main ram foundations.

    NOTE: Angle clips are welded to the foundations in this m so that heavy set screws may be used through the cli adjust the unit fore and aft, port and starboard. clips must be drilled and tapped for 3/4" bolts.

18. Drill holes for 3/4" jacking screws through the base o unit as shown in Fig. 289 at "b" according to the dimen given. See Fig. 277.

19. By means of the jacking screws through the unit base and th screws through the angle clips, adjust the position of the ram and cylinder until the athwartship center line of the r at right angles to the vertical center line of the rudder and at right angles to the fore-and-aft ship center line. Fig. 277, 90° angles. (See Fig. 280).

    NOTE: Figure 290 at "g"-"g" tiller jaws, shows a dimension The distance from tne top side of these tiller ja the center is the same. The center of the steer gear main cylinder must be at a point 1/4" below



Courtesy American Engineering Co.

Fig. 282--Front View of Steering-Gear Looking Aft

center, which is between the top and bottom of the tiller jaws. See Fig. 277 at "g", Fig. 282, and Fig. 290 at "g".

20. Begin at the inboard, forward corners of the port foundation ("d", Fig. 286, Chock #1), and measure for chock sizes. Fill out a chock sheet for each chock.

    NOTE: The position of each chock is numbered 1, 2, 3, 4, etc. Number each chock and its position with white paint. Mark the position of the chock on the base of the unit. Chock #2 is the next one to port. Follow in this direction (to port), and to completely around the foundation to the inboard and aft corner. Go across to the starboard and aft corner of the starboard foundation, continue from the inboard, after corner, and go completely around the foundation to the inboard, forward corners. See Fig. 286 for location of the chocks. There is a chock for every bolt hole. See Fig. 276.

21. Send the chock sheets to the shop, and order the chocks machined according to dimensions given on the sheets.

22. When the chocks are returned to the job, begin fitting the correct chocks as follows:

Courtesy American Engineering Co.

Fig. 283--Hele-Shaw Hand-Steering Pump

Fig. 283

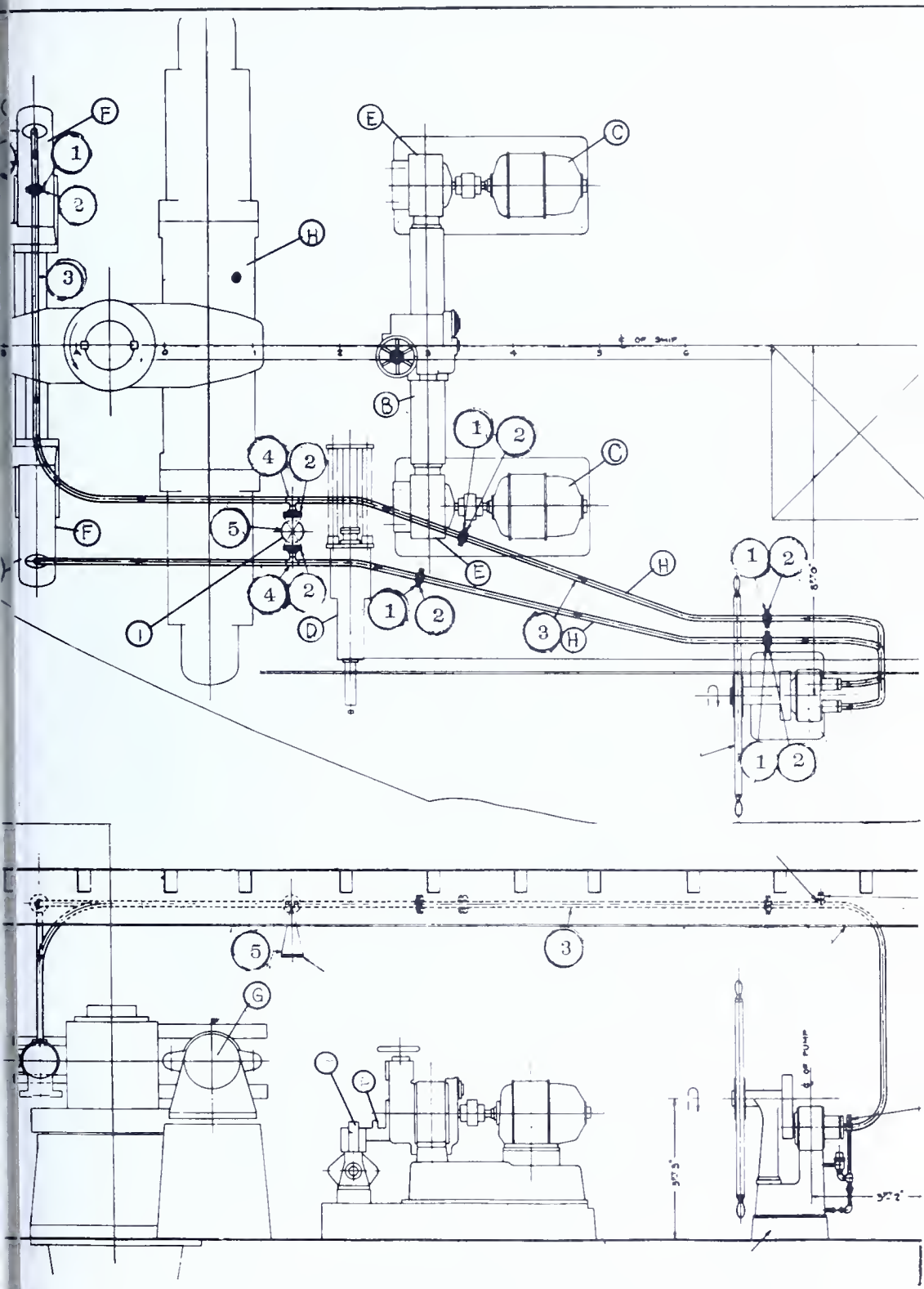
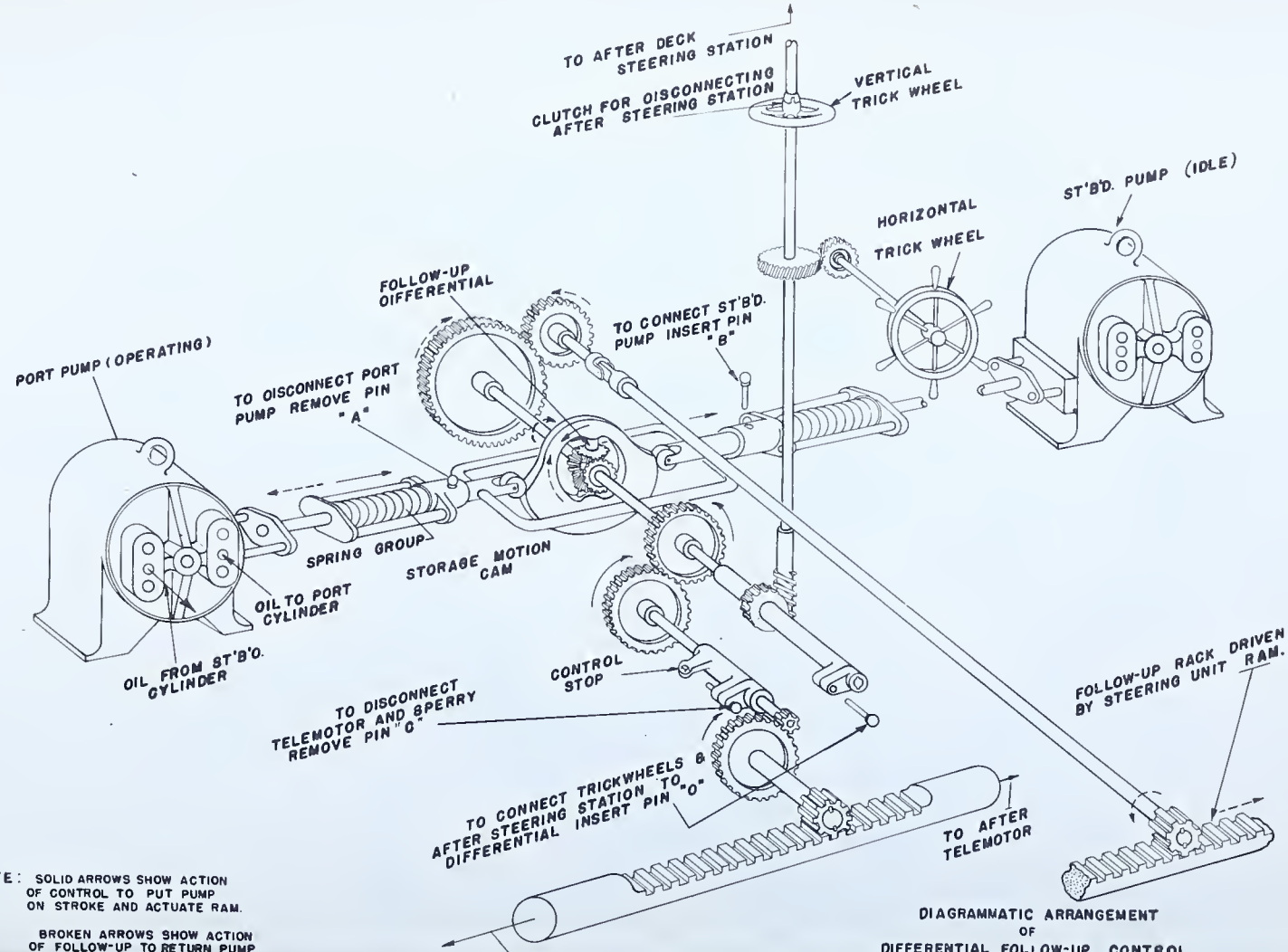


Fig. 284--Plan and Elevation of Telemotor Copper Piping

See explanation of numbers on Page 245


TO AFTER DECK STEERING STATION
CLUTCH FOR DISCONNECTING AFTER STEERING STATION
VERTICAL TRICK WHEEL
HORIZONTAL TRICK WHEEL
ST'B'D. PUMP (IDLE)
FOLLOW-UP DIFFERENTIAL
TO CONNECT ST'B'D. PUMP INSERT PIN "B"
PORT PUMP (OPERATING)
TO DISCONNECT PORT PUMP REMOVE PIN "A"
SPRING GROUP
STORAGE MOTION CAM
OIL TO PORT CYLINDER
OIL FROM ST'B'D. CYLINDER
CONTROL STOP
TO DISCONNECT TELEMOTOR AND SPERRY REMOVE PIN "C"
FOLLOW-UP RACK DRIVEN BY STEERING UNIT RAM.
TO CONNECT TRICKWHEELS & AFTER STEERING STATION TO DIFFERENTIAL INSERT PIN "D"
TO AFTER TELEMOTOR
TO AFTER

NOTE: SOLID ARROWS SHOW ACTION OF CONTROL TO PUT PUMP ON STROKE AND ACTUATE RAM.

BROKEN ARROWS SHOW ACTION OF FOLLOW-UP TO RETURN PUMP TO NEUTRAL AND STOP RAM.

DIAGRAMMATIC ARRANGEMENT
OF
DIFFERENTIAL FOLLOW-UP CONTROL
WITH CAM-TYPE STORAGE MOTION
FOR

Fit #1 chock 1st. (See Step #5)
Fit #7 chock 2nd.
Fit #8 chock 3rd.
Fit #14 chock 4th.

(These chocks are on the port foundation.)

Fit #15 chock 5th.
Fit #21 chock 6th.
Fit #22 chock 7th.
Fit #28 chock 8th.

(These chocks are on the starboard foundation.)

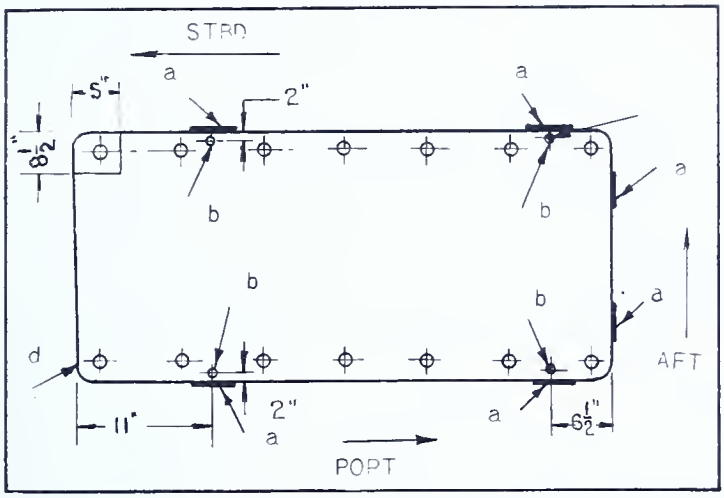


Fig. 286--Port Foundation for Main Steering Ram

NOTE: Corner chocks are fitted first as outlined above because they will then serve as a reference when fitting intermediate chocks. Example: when numbers 2, 3, 4, 5, and 6, are being fitted the base of the unit could easily be raised and the job thrown out of line. As each chock is fitted, the corner chocks are checked with a thickness gauge to make sure they are tight. The corner chocks should be checked frequently while the other intermediate chocks are being fitted.

23. Fit the intermediate chocks.

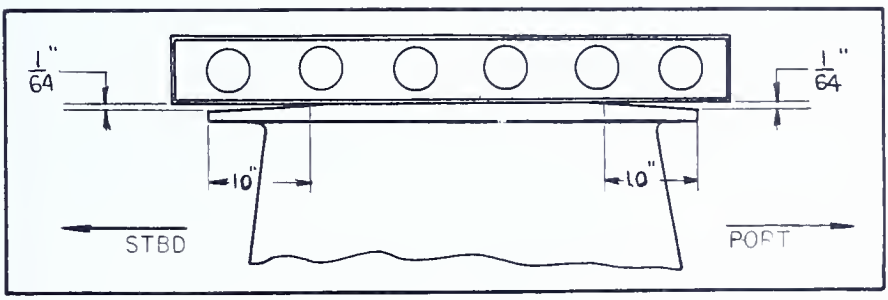


Fig. 287--Checking Foundation Top with a Straightedge

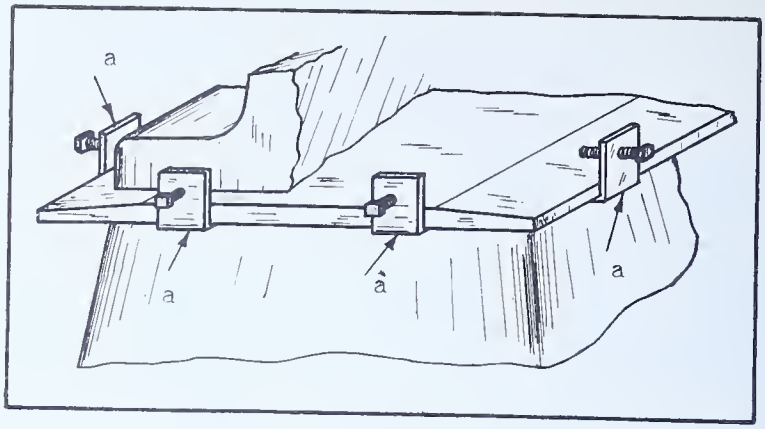


Fig. 288--Jacking Screws Tack Welded to Foundation Top

24. Scribe through the holes in the unit base on all eight corn and mark the position of the holes which are to be drille the corner chocks.

25. Remove the corner chocks, and center punch mark the circum ence of each hole. Find the center of the holes with the di ers; center punch mark the centers; and send the chock the machine shop for drilling. Give the machine shop the of holes required.

26. When the chocks are returned, place them in position and drill the holes through the foundation, using the hole in the unit base for a guide. See Fig. 61.

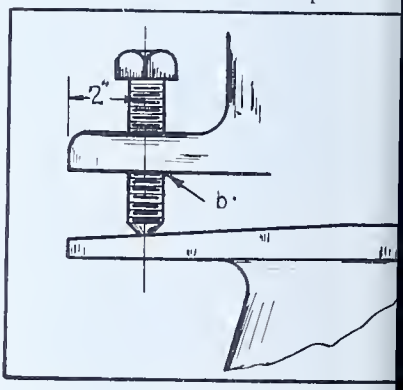


Fig. 289--Adjusting Scre Through Base

BILL OF MATERIALS

A partial bill of materials which goes into the fabrication and assembly of a steering engine is given below. To identify the type and grade of material, compare the key-number on the Figures 284, 297, 299, with the bill of materials.

For example: The number 12 in the circle in Fig. 297 is foun the column at the left in the bill of materials. Reading across

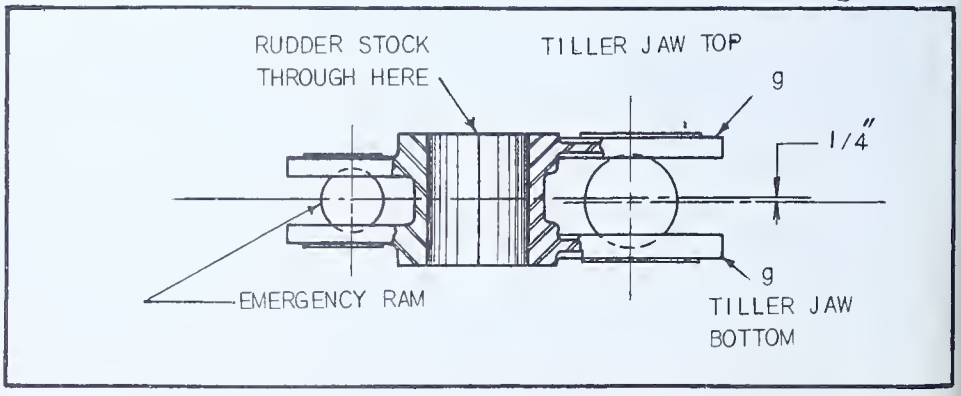
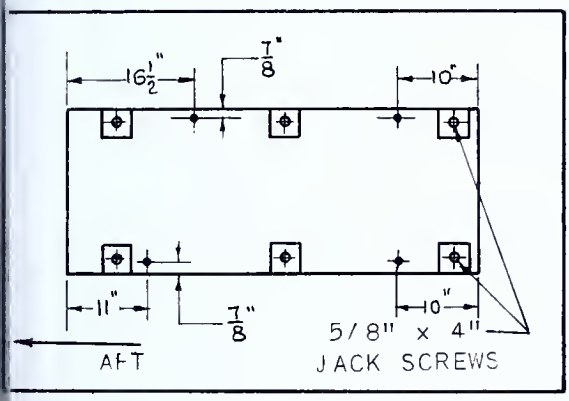


Fig. 290--Tiller Jaw Center $\frac{1}{4}$" Above Ram Center

e number, we find 3/4" standard 90° Ell, brass. In the small circles Fig. 297 will be found the number 12. Each number 12 on the Figure eans that the materials given opposite 12 in the bill of material are be used at that point.

Follow this same procedure with all the other numbers in the circles these three figures.

In Fig. 277 the letter "s" is found in one of the circles. This terial is 1" square packing.



g. 291--Pump and Motor Unit Foundation

NOTE: When because of limited working space it is impossible to drill a full-sized hole in the foundation, the workman places a bushing in the hole in the unit base and drills a pilot hole with a small drill. It is then possible to get under the foundation with a large drill and a drilling machine and drill the hole to the full size from below.

27. When the corner holes are drilled, ream them to size as shown on the blueprint.

28. Order 28 fitted bolts to fit the reamed holes. Give the machine shop the sizes of the bolts.

29. When the fitted bolts are ready, install them on all eight corners first and draw up snugly.

    NOTE: The corner bolts are fitted first to prevent any possible misalignment of the unit.

30. Scribe through the unit base holes, and mark the hole locations on all the intermediate chocks. Locate the centers as in step 10.

31. Send the chocks to the machine shop to be drilled. Give the shop the size of the hole.

32. When the chocks are returned, install them in the correct location and ream as in step 12.

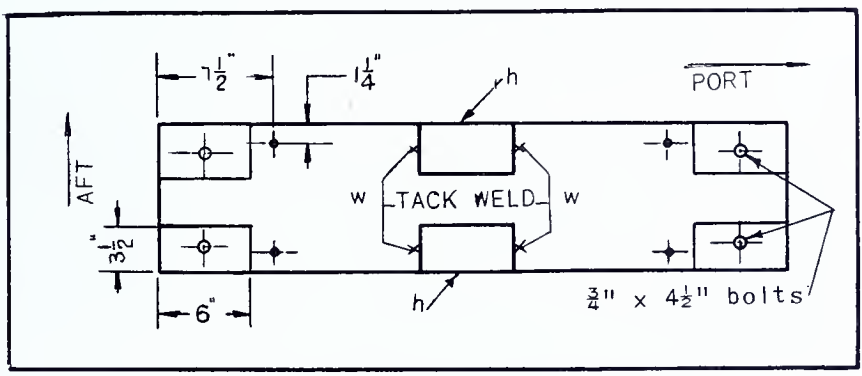


Fig. 292--Telemotor Foundation

33. Install the remainder of the fitted bolts, and pull them snugly.

34. Install port and starboard motor and pump units "k" (See Fi 280, Fig. 281, and Fig. 282) according to the blueprint.

NOTE: Follow-up gear "L" must be installed and lined up the same time the motor and pump units are installe This is done to insure the correct alignment on a three units. These units are lined up with jacki screws for height and position as was done when lini up the main cylinder and ram units. See Fig. 289.

35. Fit the chocks and install the fitted bolts as was done wi the main cylinder and ram units. See Fig. 291 for locati of bolt holes.

INSTALLING THE TELEMOTOR

Figure 284 at "p", shows two small lugs connected by a pin. The p must be a slip fit through both lugs, and it must slide easily. T forward lug is connected with the follow-up gear and the after lug part of the telemotor leg which is connected to the telemotor.

The foundation for the telemotor is shown at "e", Fig. 279. T telemotor is shown at "t", Fig. 277, and at "t", Fig. 280. The tel motor must be installed on the foundation and aligned with the follo up gear. Figure 285 shows the follow-up gear and the pin at "c". S Fig. 292 for location of bolt holes in the foundation.

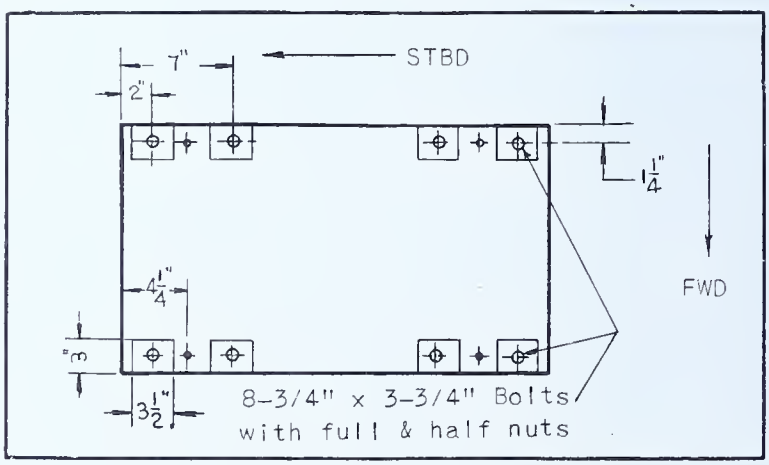


Fig. 293--Telemotor Rack Foundation

PROCEED

36. Install the telemotor rack and align with the follow-up gea See Fig. 279 at "d" for location.

37. Chock the telemotor and bolt down. See Fig. 293 for locati of bolt holes.

38. Install the telemotor and align it with the telemotor rack.

39. Chock the telemotor and bolt down.

NOTE: Check frequently to insure the sliding fit of pin "p". Figures 277 and 284.

40. Install the follow-up gear universal control rod "U", shown in Figs. 277 and 280.

NOTE: Figure 292 shows two chocks at "h-h" which do not have bolts. These chocks act as a support under the telemotor, midway between the end chocks, and are tack welded as shown at "w-w". Care must be taken to have the welders tack these chocks to the foundation.

RGENCY, HAND-STEERING MECHANISM

Figures 277, 280, and 284 show the emergency, hand-steering cylinder ram. Figure 279 "B" shows the foundation for these parts.

41. Install the emergency, hand-steering cylinder and ram units, and align the center line of the unit in the same manner as was done in step 4 in aligning the main ram and cylinder. See Fig. 294 for location of bolt holes.

42. Chock the unit, and bolt down.

E-LEVER UNIT

In step 7 the brake band was alled to be connected to the e lever later on. The brake- r unit is now to be installed. re 279 at "f" shows the founda- for the brake-lever unit. re 280 at "v" shows the brake- connection with the brake r. Figure 280 also shows the e-lever adjusting screw at "w". adjusting-screw unit must be alled at the same time as the e lever in order to secure a ect alignment. Figure 303 shows

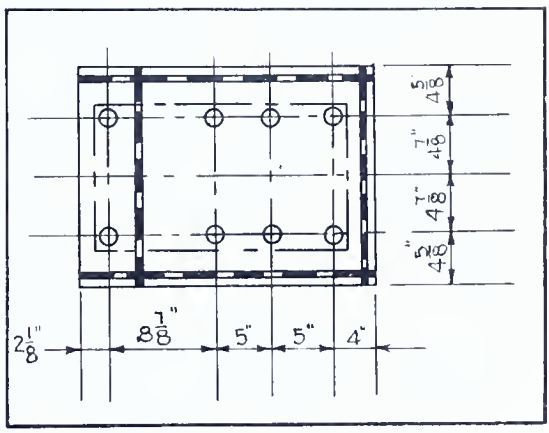


Fig. 294--Emergency Hand-Steering Cylinder and Ram Foundation

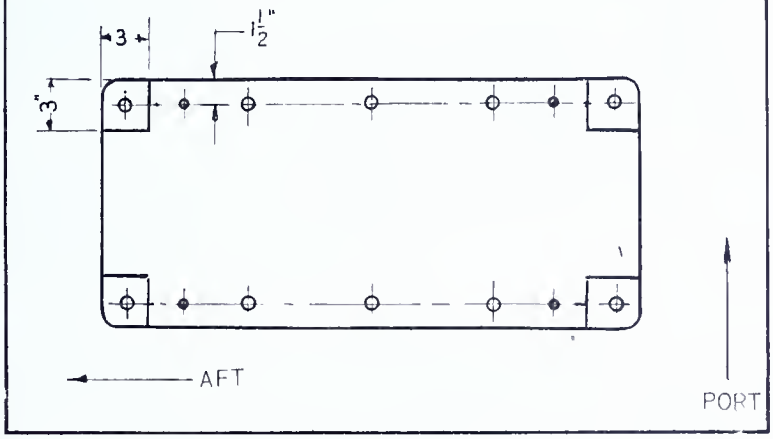


Fig. 295--Brake Foundation

the brake, the brake lever, and the brake-adjusting screw assemble the foundations, in Figs. 295 and 296.

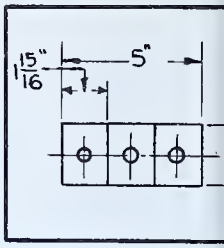


Fig. 296- Screw Foundat

INSTALLING THE BRAKE LEVER AND SCREW

The brake lever and the brake-lever adjusting-screw units are now installed and aligned with the brake band which was previously placed in position on the brake drum. The brake edges must line up with the flanges on the brake drum and not "cross" the plane of the brake-drum flanges. When the alignment is correct, the bottom edge of the brake should clear the bottom flange of the brake drum about 1/16 of an inch. The bas each of these units is adjusted to the correct height with jacking sc When the alignment is correct, the chocks are fitted, drilled, rea and bolted down according to standard procedure.

HAND PUMP AND FILLING TANK

Figure 298 shows a hand pump and a filling tank both of which parts of the telemotor system. The liquid for the hydraulic mecha is poured into the tank, and the pump is used to circulate the li and distribute it throughout the telemotor lines. The foundation the pump is two 3" angles welded to the deck after the pump has bolted to the angles. An angle foundation for the tank is welde the deck, and the tank is strapped down securely.

HELE-SHAW HAND-STEERING PUMP

Figure 280 at "y" shows a hand steering pump which is used for emergency steering when the electric power fails on the main unit. Turning the hand wheel operates the pump which in turn operates the emergency rams "R-R", Fig. 280.

The unit is bolted to the foundation, without chocks. A shim may be used to compensate unevenness in the foundation.

The holes in the foundation are located from the base of the unit which is already drilled when received. See Fig. 297 for the locations of the holes in the foundation. The unit is lined up with the bulkhead.

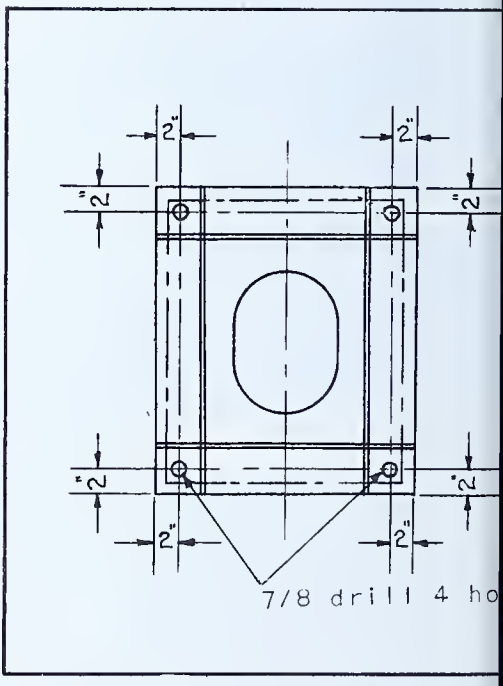


Fig. 297--Hand-Steering Pump Found

STEERING-GEAR CONTROL

Figure 299 shows the steering-gear control in the wheelhouse a the wheelhouse top. Figure 300 is a cross-section view of the ba the steering-gear column in the wheelhouse. Figure 301 is a cross tion view of the base of the steering-gear column on the wheelhouse Bosses are welded to the deck as at "a". Studs are screwed int

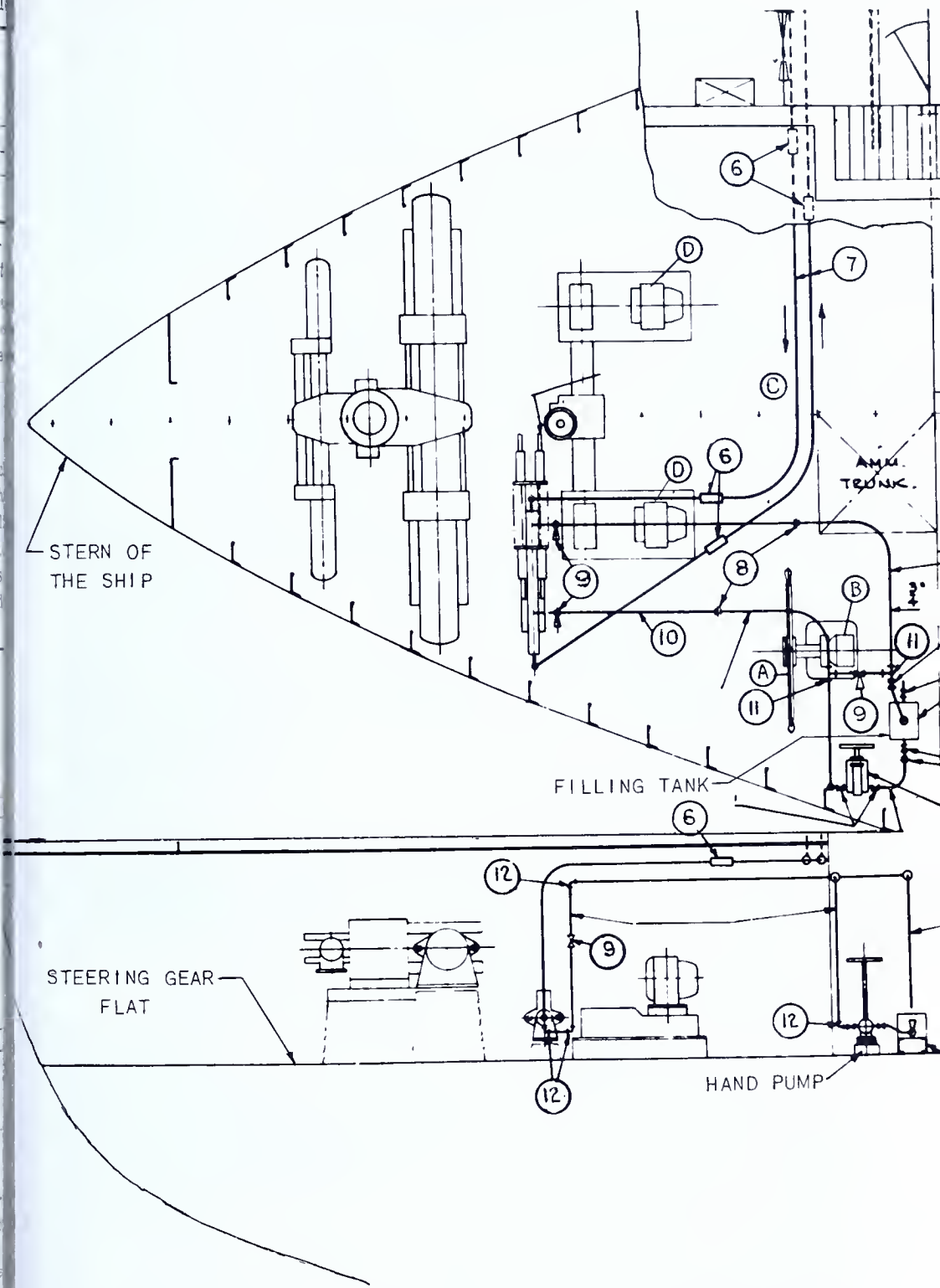


Fig. 298--Plan and Elevation of Telemotor System in Steering Gear Room

See explanation of numbers on Page 245

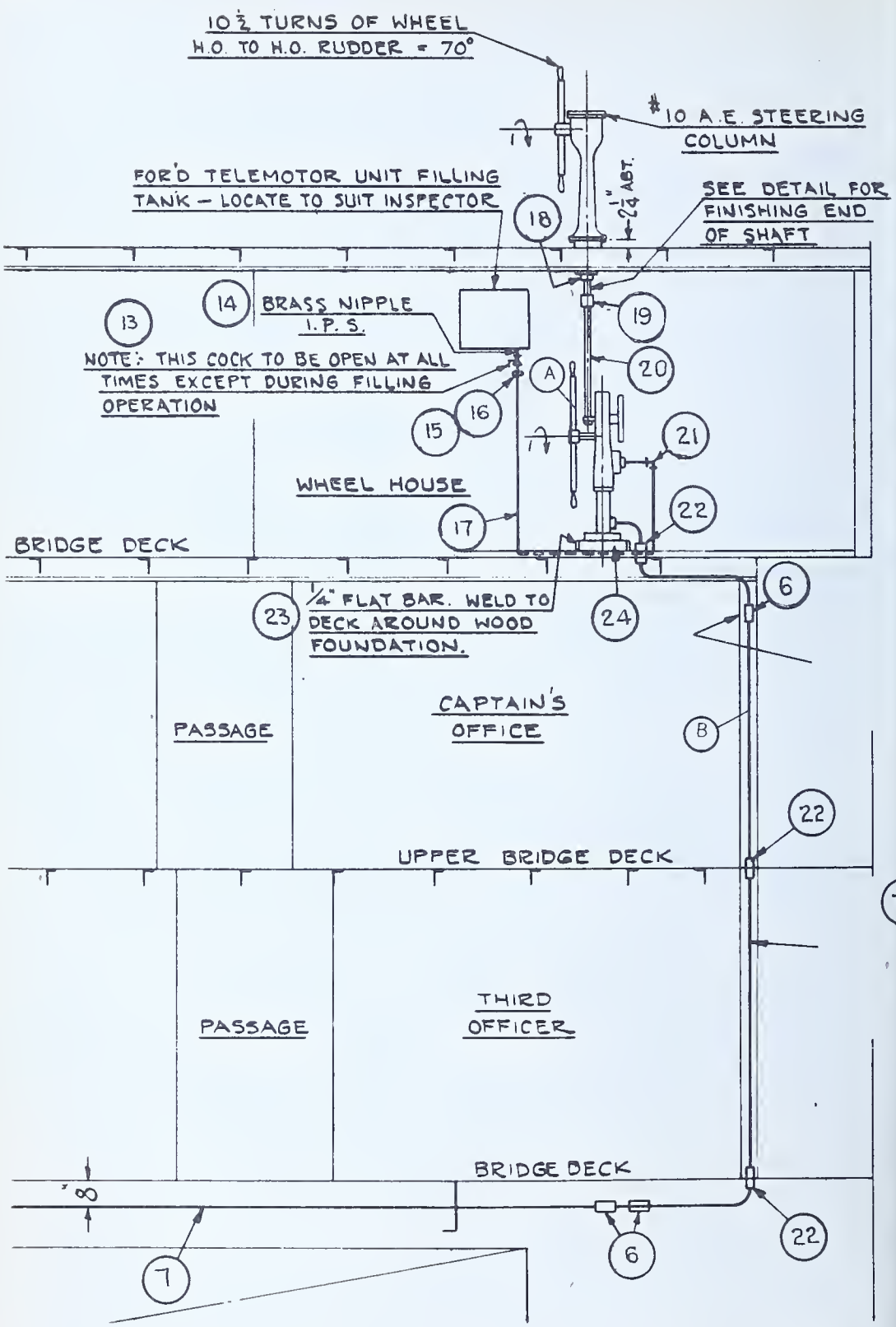


Fig. 299--Elevation of Telemotor Piping System Connected with the Wheel-House Controls

See explanation of numbers on Page 245

sses, and teak-wood blocks about 3" thick are placed as shown. The rward telemotor is installed as shown in Fig. 300 and bolted down. e steering-column shaft is connected to the telemotor by means of a utch. Either steering wheel can be used to operate the telemotor and control the steering gear. The forward, telemotor-unit filling tank installed as shown in Fig. 299.

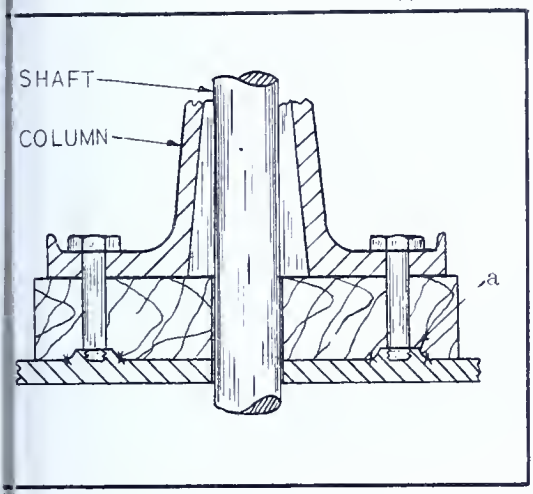


Fig. 300--Telemotor Column Base in the Wheel House

Figure 302 is part of a steam-erated steering gear showing tele-tor-to-throttle-valve control and tick-wheel control.

The installation is now ready for piping. The coppersmiths connect the piping from the forward telemotor on the bridge to the after telemotor. The coppersmiths also install the piping between the filling tank and the telemotor.

The installation is now ready for trial operation.

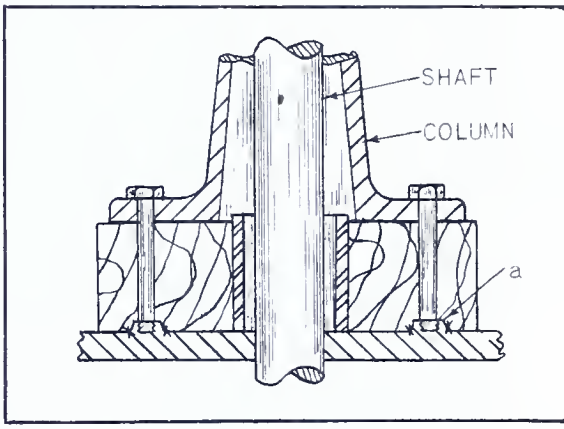


Fig. 301--Telemotor Column Base on the Wheel House Top

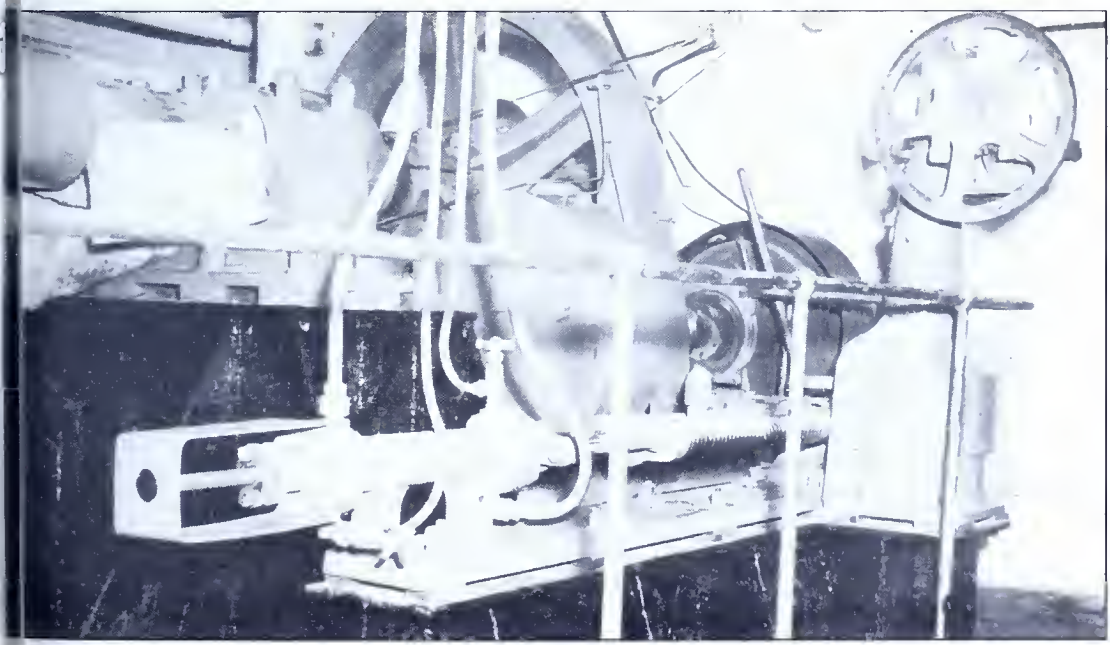


Fig. 302--Steam Operated Steering-Gear

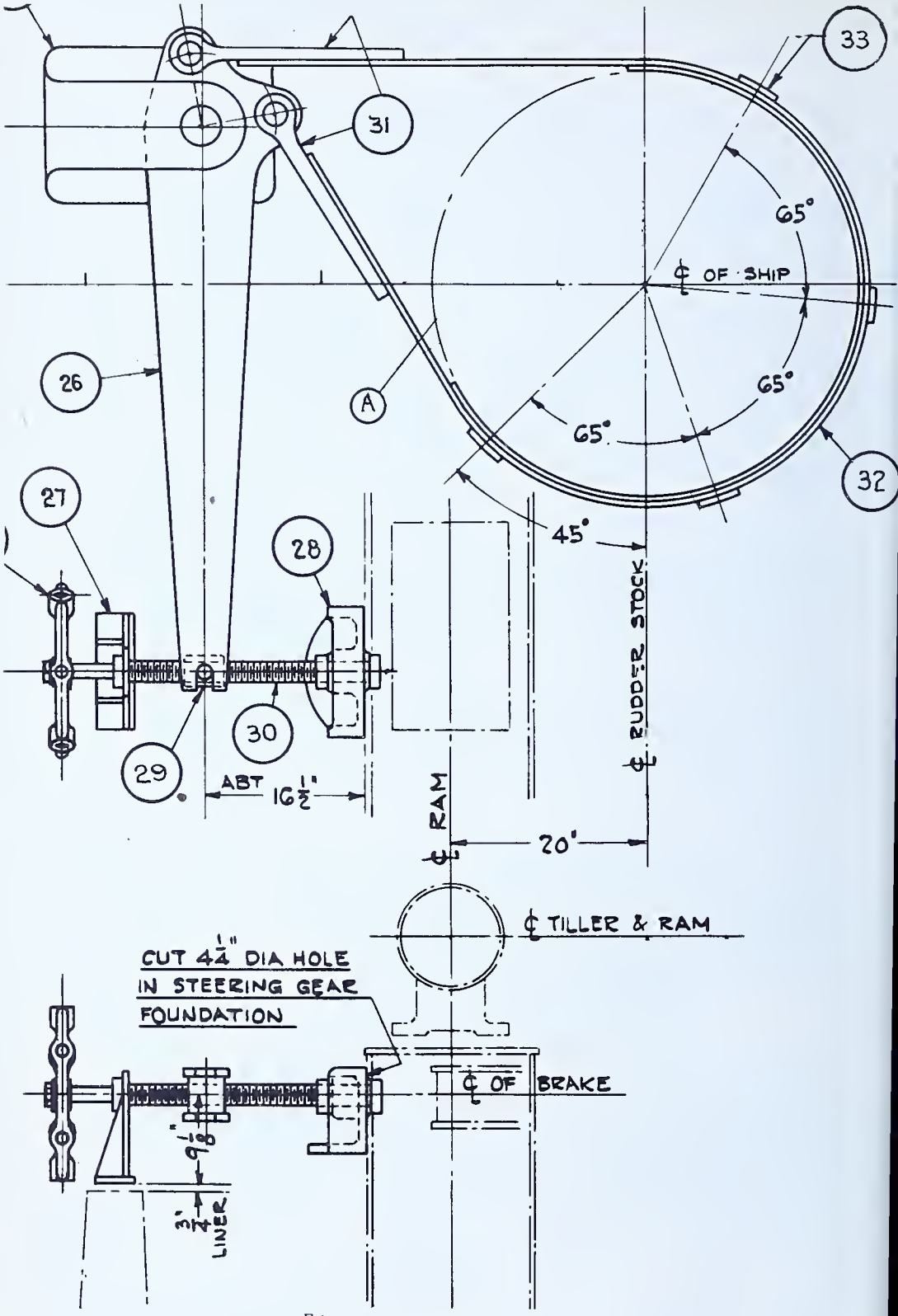


Fig. 303--Brake Lever Unit

See explanation of numbers on Page 245

EXPLANATION OF NUMBERS ON FIGURE 284

1" Flg. (600#) -	F.S. Male End Slip on	Type 241-585-5
1" Flg. (600#) -	F.S. Female End Slip on	Type 214-585-5
1" Tubing	Seamless Steel	Ex. H.Y. IES
1" Welding Tee -	Seamless Steel	Ex. H.Y. Pipe Thkss.
1" By Pass Valve	F.S.	241-858-5

EXPLANATION OF NUMBERS ON FIGURES 298 and 299

Coupling	C.R.S.
Telemotor Pipe	S.D. Copper
3/4" Std. Union	Brass
3/4" Std. Scr. Globe Valve	Brass
3/4" Pipe	Brass
3/4" x 3/4" x 3/4" Std. Tee	Brass
3/4" Std. 90° Ell	Brass
1/2" cock	Brass
1/2" Nipple	Brass
Male Connector	5/8" tube size
Union Nut	5/8" tube size
5/8" O.D. Tubing	S.D. Copper
Bracket	Comp. "G"
Coupling	Brass
Shaft, 1-7/16" diam.	Brass
Union Elbow	5/8" tube size
Stuffing Box	Complete
Flat Bar	Steel
Blocking	Teakwood

EXPLANATION OF NUMBERS ON FIGURE 303

Brake Lever - C.S. 175-858	51/1 -	Annealed
Bracket	Steel	Complete
Bearing	C.I.	5-930 92/3
Nut	Comp. "G"	37-383-551
Spindle	F.St.	A.B.S. Grade #2
Brake-Band EHD	F.St.	A.B.S. Grade #2
Brake Band	Steel	Flat bar-7/8 x 4-3/4 x 14'-0" long.
Bracket	St.Pl	5" x 4" x 1/2" each

Installing A Propeller And Tail Shaft

THE PROPELLER

The propeller, Fig. 304, is usually a bronze casting wei approximately seventeen tons. The propeller casting is balanced the hole in the hub for the tail shaft is bored in the machine A template is used when boring the propeller, the use of which s insure a perfect fit between the tail shaft and the propeller bore.

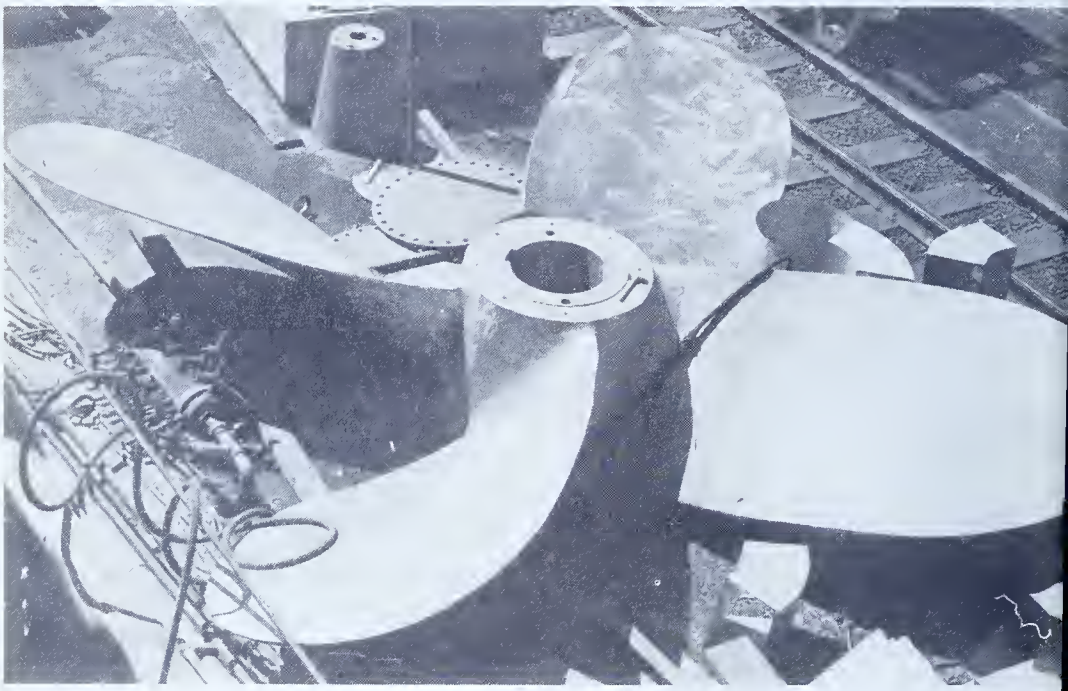


Fig. 304--Typical Bronze Propeller

THE TAIL SHAFT IS PLACED FIRST

The tail shaft, Fig. 305, is lowered into the engine room ship riggers and passed through the stern until flush with the eye propeller hub and tail shaft must be free of dirt and grit when together.

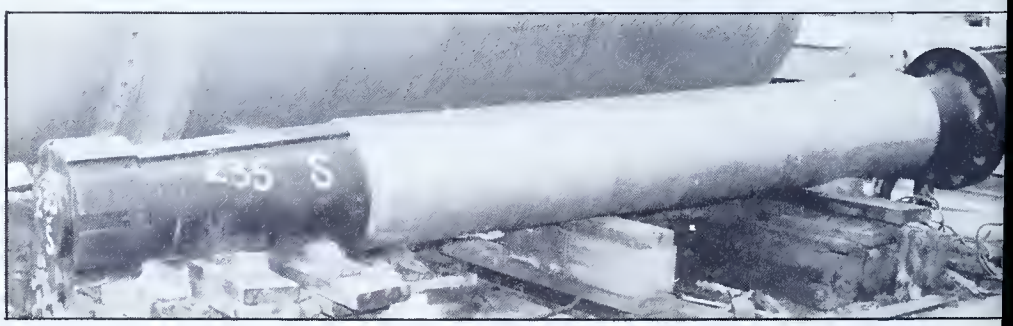


Fig. 305--Tail Shaft Fitted with Bronze Sleeve

ACING THE PROPELLER IN POSITION

The propeller is lowered into ace by the ship riggers. Pads ve been welded at suitable loca- ons on the ship shell to port and starboard. As the crane man wers the propeller to place, chain lls, hung from the pads, receive and it is swung into place aft the stern-frame eye and in line th the tail shaft. Roll the tail aft until the key in the taper is ir with the keyway in the hub. e Fig. 306. The tail shaft is now shed out and into the hole in the opeller hub. The lock nut is xt installed and run on to within ree inches of the after end of e hub. See Fig. 307.

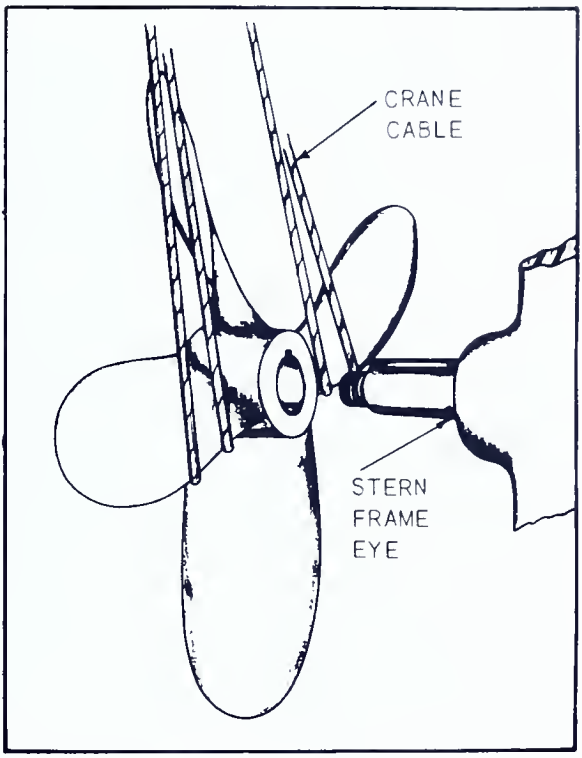
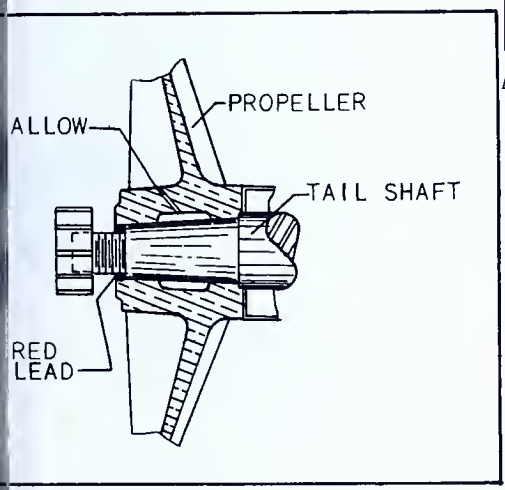


Fig. 306--Key and Keyway Aligned to Fit.

RCING THE PROPELLER ON THE TAIL AFT



g. 307--Lock Nut on Tail Shaft

The approved types of wedges and boxes are then installed between the lock nut and propeller hub for the purpose of forcing the propeller on to the taper of the tail shaft.

A turn of red lead is inserted into the space (about 3/4" deep) between the tail-shaft shoulder and the eye diameter. See Fig. 307.

INSTALLING A PROPELLER AND TAIL SHAFT

The nut is then run up against the after end of the hub by means of a heavy, special spanner wrench. A avy chain fall is anchored to the eg and hooked on to the outer end the spanner wrench. With a steady rain on the chain fall and with re- ated blows of a 30-lb. sledge on e outer end of the spanner, the hinist snugs home the lock nut ainst the after end of the stern- ame eye. Check with the leader r his approval.

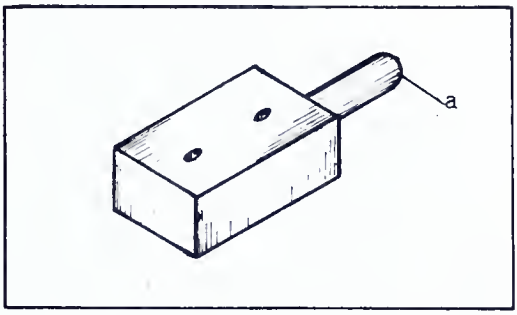


Fig. 308--Locking Device

SECURING THE LOCK NUT

The chain fall, spanner wrench, and other equipment are now removed and returned to the tool rooms. A special locking device is installed to prevent the propeller lock nut from loosening. See Fig. 308. A hole just large enough to take the pin "a" (Fig. 308) is drilled into the after end of the propeller hub. The hole is located in a convenient notch in the lock nut. See Fig. 309. Holes are drilled and tapped in the lock nut to fit the holes in the locking device, Fig. 309. The pin shown in Fig. 308 is inserted in the drilled hole in the propeller hub, and cap screws are used to fasten the device securely in the lock-nut notch.

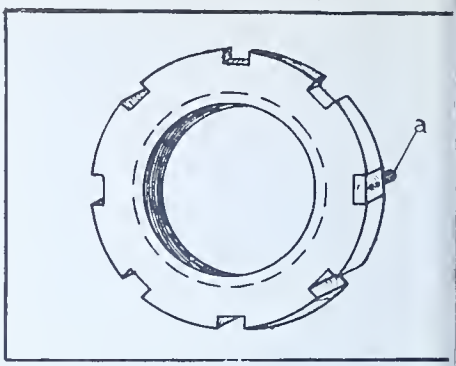
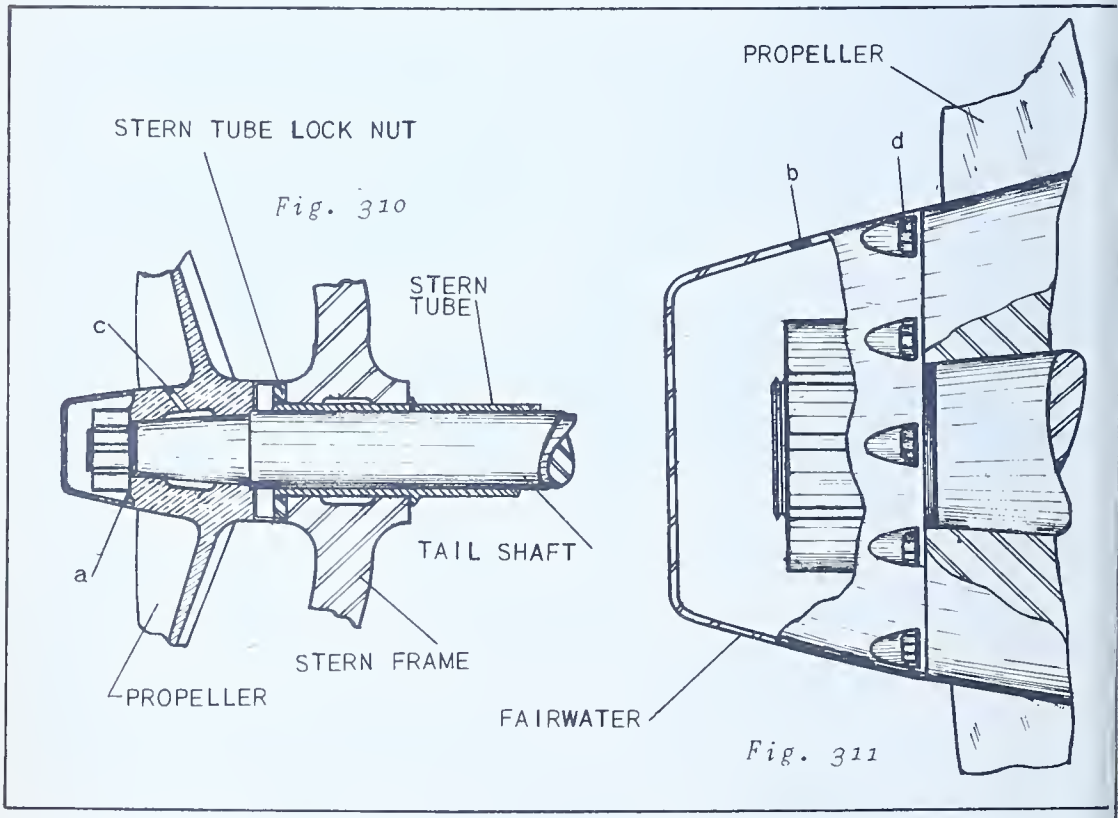


Fig. 309--Tail Shaft Lock Nu



Figs. 310 and 311--Fairwater Installed Over Propeller Lock Nut

SEALING THE LOCK NUT

A fairwater is installed over the after end of the propeller hu for the purpose of sealing the lock nut and protecting it from seawate See Fig. 311. After the fairwater is installed, it is filled with ta low through the hole provided (b), and a pipe plug is screwed in secur ly. See Fig. 311. A similar hole is provided in the propeller hu through which tallow is poured to seal the tail shaft against corrosi should possible leaks occur. See Fig. 310 at "c".

After the fairwater is bolted to the propeller hub, the counter-red, bolthead openings, Fig. 311 "d", are sealed over with cement which events the loss of the bolts and also protects the boltheads from rrosion by salt water.

The job of installing the propeller and tail shaft may be outlined follows:

OCEDURE

1. Lower the tail shaft into the engine room.
2. Pass the tail shaft aft until the outer end of the threaded portion is flush with the stern-tube lock nut.
3. Lower the propeller into place on chain falls, fair with the stern-tube bore.
4. Roll the tail shaft until the key in the taper is fair with the keyway in the propeller.
5. Push the tail shaft through the stern tube, and engage the tapered bore in the propeller hub.
6. Install the lock nut, and run it on to within 3" of the after end of the hub.
7. Draw the propeller hub on to the tail-shaft taper by means of wedges and boxes.
8. Insert a turn of red lead between the tail-shaft shoulder and after face of the propeller.
9. Turn the nut home by using the special spanner wrench, chain fall, and 30-lb. sledge.
10. Remove the chain falls and other equipment, and return them to the tool room.
11. Install the lock nut and lock key.
12. Install the fairwater.
13. Fill the fairwater recess and the propeller-hub recess with tallow. Insert pipe plugs and make tight.
14. Cement fairwater bolthead openings.

Launching a Tanker

GENERAL INFORMATION

The outside machinist has several important jobs to perform be a ship can be launched. Docking plugs must be screwed in place; ship's rudder must be securely locked in a central, fore-and-aft po tion and the propeller must be firmly held so that it cannot turn v the ship slides into the water. In the bottom of a tanker there forty-seven docking plugs. See Fig. 312.

Metal flanges are threaded to fit the plugs shown in Fig. 312. The flanges are welded in openings in the ship's bottom.

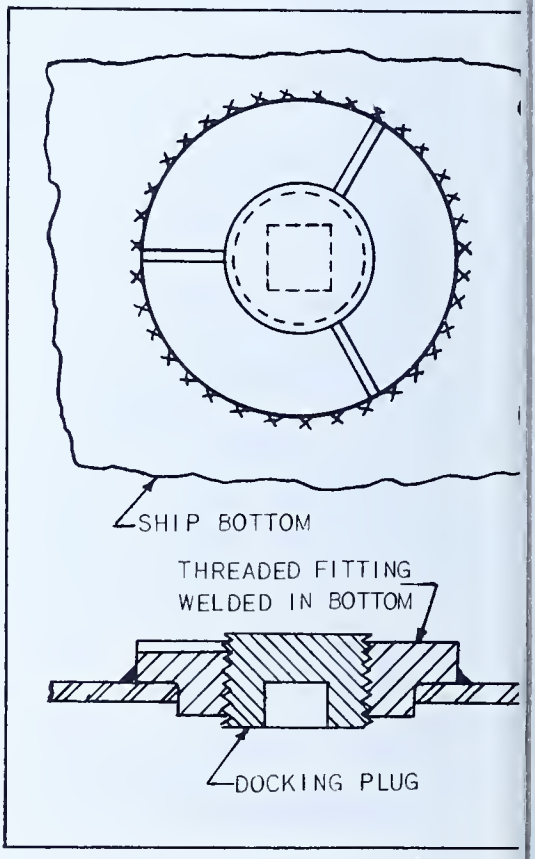


Fig. 312--Docking Plug Assen

PURPOSE OF DOCKING PLUGS

The openings are located in the bottom so that every tank in the ship may be drained through them. A docking plug is screwed into the threaded hole in the flange before the ship is launched.

While the ship is on the ways and before the docking plugs are finally screwed in place, lengths of pipe equipped with valves, are temporarily screwed in place and the valves are closed. The tanks are filled with water to test them for leaks. When the tanks have been tested and approved the valves in the pipe lengths are opened and the water is drained. The docking plug is then screwed in place by means of a wrench which fits the square hole in the plug. See Fig. 312. When a ship is placed in dry-dock the docking plugs are removed to allow all the water or other liquid in the tanks and bilge to drain. Oil tankers are washed out live steam and the accumulation of water and oil is drained out thr the docking plug openings.

LOCKING THE RUDDER

When the ship slides down the ways, See Fig. 313, there are sev thousand tons of dead weight to control after the ship is in the wa The rudder must be securely locked so that it can not be slammed ar by the water pressure as the ship leaves the ways. There are two by means of which this is accomplished:

1. SECURING RUDDER WHEN THE RUDDER STOCK IS INSTALLED

The riggers install cables at the stern of the ship. The cables are stened from the rudder, port and starboard, to pads which are welded to e ship shell, port and starboard. The cables are drawn up taut and ie fast.

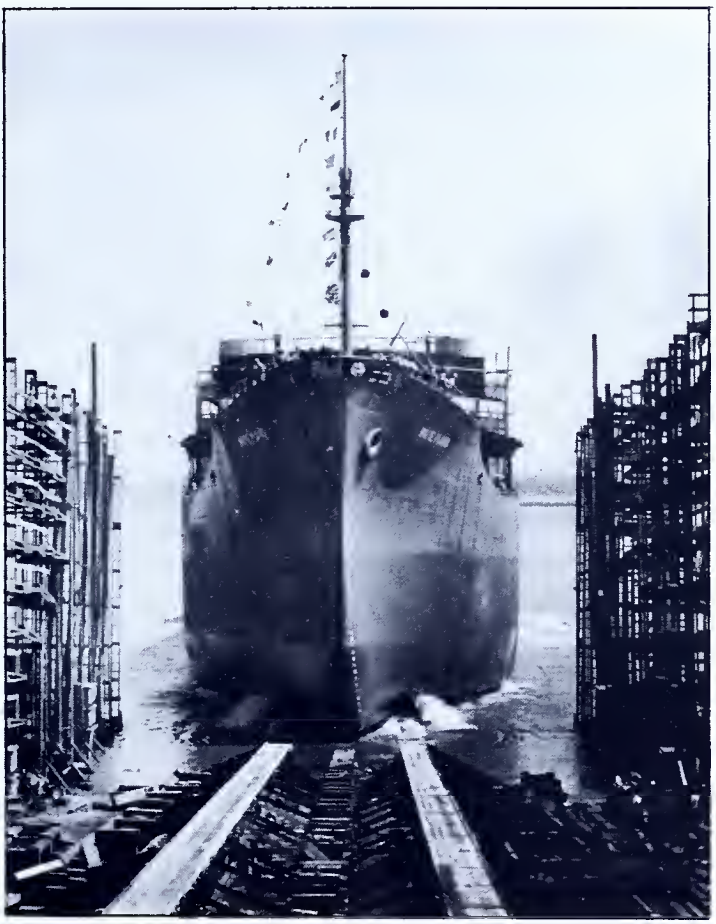


Fig. 313--The Ship Sliding Down the Ways

On the inside of the ship, Fig. 314, chain falls are fastened to the ller jaws; one chain fall to port and one chain fall to starboard. The ier end of each chain fall is fastened to the ship's frame, port and rboard. The braces take the strain as the pull of the chain falls is rted on the tiller jaws. With the braces in place the chain falls are led up tight and locked, thus adding extra force inside the ship to sist the force of the cables installed outside of the ship by the gers.

2. SECURING RUDDER WHEN THE RUDDER STOCK IS NOT INSTALLED

Rudder stops are provided at the stern to prevent the rudder from swinging more than 37½ degrees to either port or starboard. See Fig. 315.

When the rudder is in a central fore and aft position there is a space about 7 inches wide between the rudder stops and the rudder bumpers. The riggers install cables at the stern of the ship as before. With the rudder held exactly fore and aft, ¾" to 1" thick plates about 7" wide are temporarily welded in the space

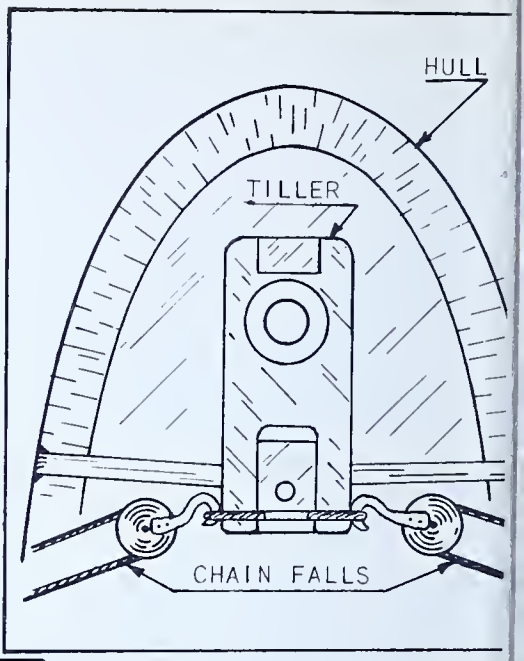


Fig. 314--Chain Falls Attac Tiller Jaws

left between the rudder stop the rudder bumpers. See Fig. Whichever method is used, work is supervised and check the outside machinist.

HOLDING THE PROPELLER STATI

The rush of water against propeller as the ship slides the ways is sufficient to the propeller revolving. must never be allowed to ha Means must be provided to the propeller shaft and thus the propeller. Fig. 316 sh pair of heavy bars of steel fit around the coupling fl of the line shaft in the alley. It will be noted the semi-circular cut-out i center of each bar is fo purpose of allowing the ba reach around the line shaf enough for the bolts i coupling flanges to pass th the bars.

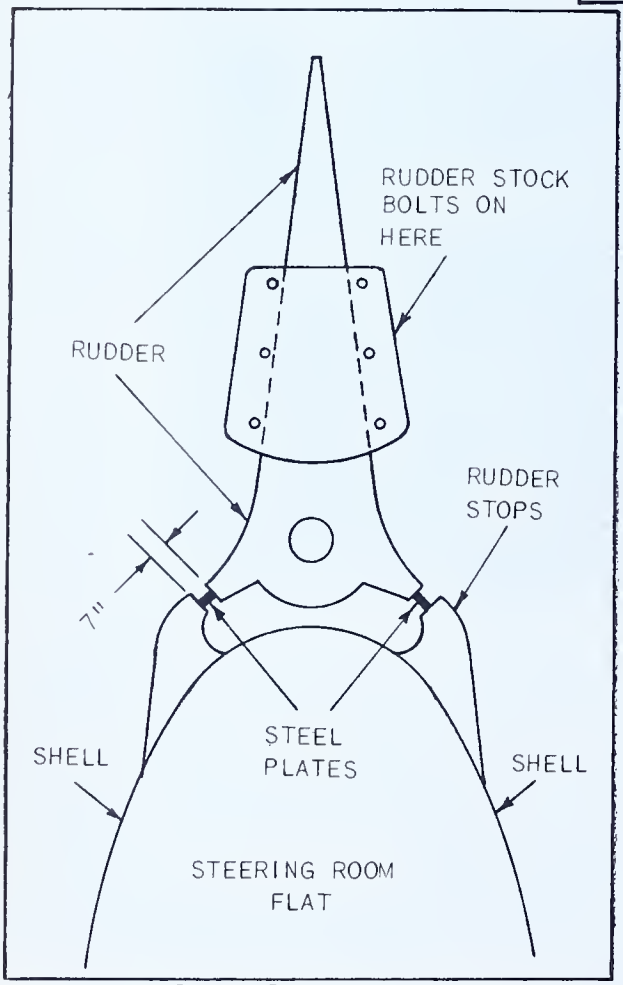


Fig. 315--Steel Plates are Welded to Rudder and Rudder Stops

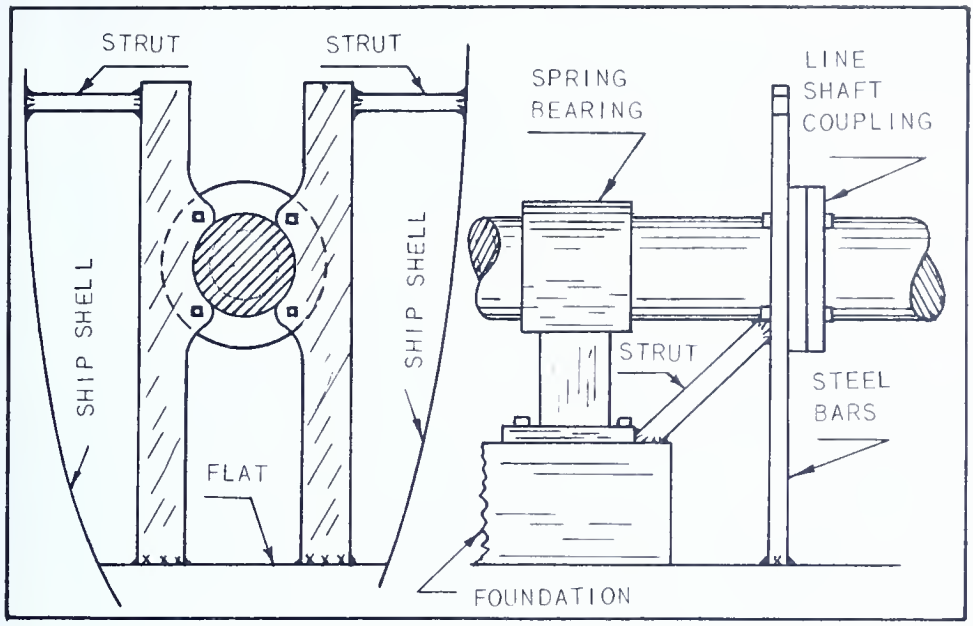


Fig. 316—Heavy Bars and Struts to Keep the Line Shaft From Turning

After the bars are bolted in place the lower ends of the bars are temporarily welded to the deck and the upper ends are braced by struts welded to the port and starboard sides of the ship shell.

When the ship is about ready for launching the docking plugs are all screwed in and inspected under the supervision of the outside machinist. Leaving a plug out or neglecting to screw a plug in would be equivalent to drilling holes in the ship's bottom. Every docking plug must be snugged home securely to prevent any possible leakage.

QUESTIONS

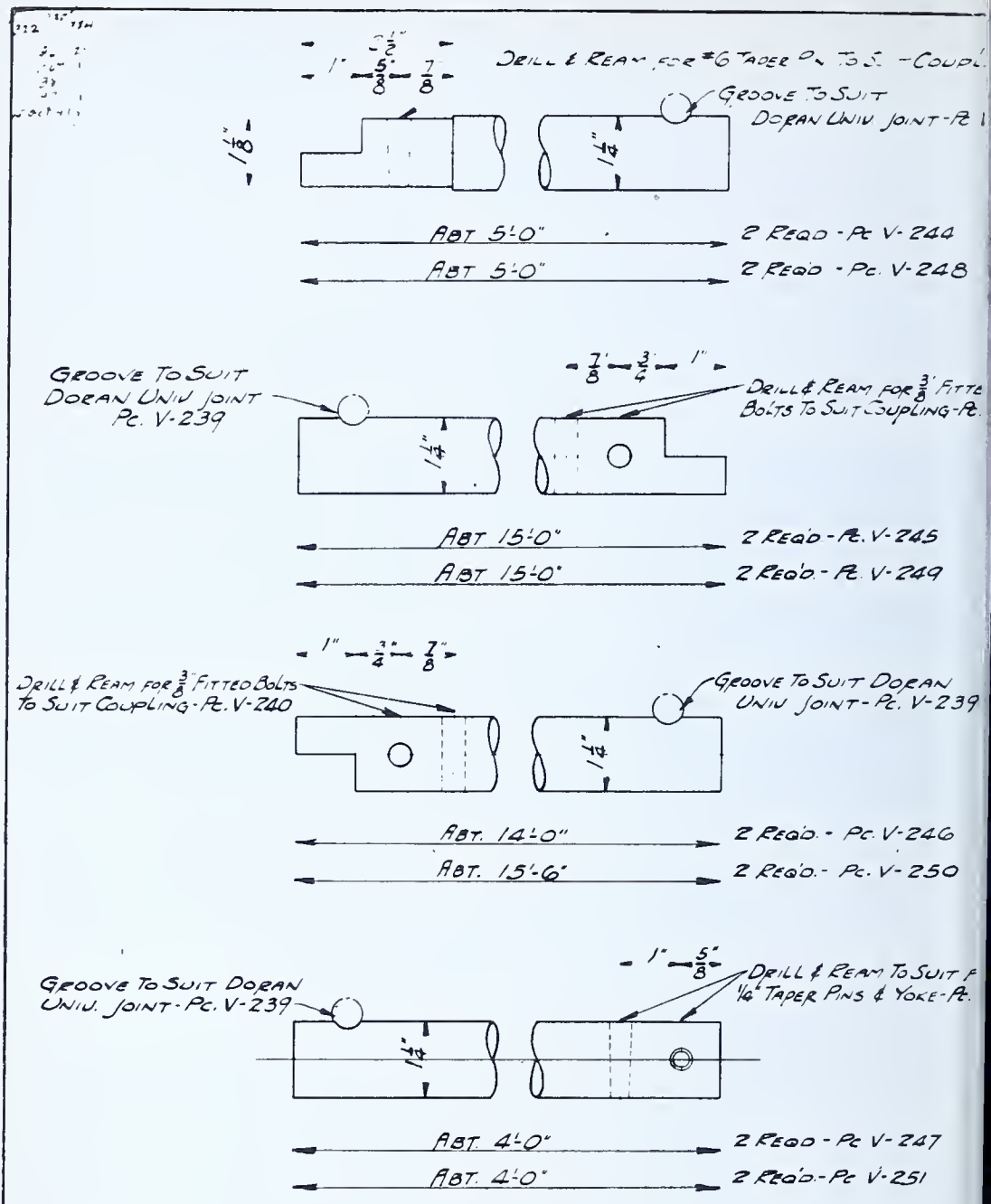
1. What is the purpose of a docking plug?
2. How is a docking plug flange installed in a ship?
3. Where are docking plugs located?
4. Why are docking plugs inspected carefully before the ship is launched?
5. Why must the ship's rudder be securely blocked in place before the ship is launched?
6. Describe the blocking operation as it is carried through when the rudder is installed.
7. Describe the blocking operation as it is carried through when the rudder stock is not installed.
8. Why must the ship's propeller be prevented from turning when the ship is launched?
9. Describe the method employed to lock the propeller in position while the ship is being launched.
10. Make a list of the accidents and happenings that might take place if any of the duties of the outside machinist, as outlined in this lesson, were left undone.

APPENDIX I

Typical Drawings That Outside Machinists Must Be Able To Read

Since all outside machinists are required to read blueprints which locations of holes, sizes of holes, and locations of certain units e installed, and since this manual is not intended for comprehensive ruction in blueprint reading, the following specimen prints are ted so that the outside machinist trainee may develop an appreciation he types of blueprints which he must learn to read as a part of his work.

Following the prints are questions pertaining to each print. The tions are typical of information which the outside machinist must be to obtain readily from blueprints. All the questions may be answered the prints shown here. Most answers may be found from the specific under which the question is listed.


1" 5/8 7/8 1/2
DRILL & REAM FOR #6 TAPER PIN TO S. -COUPL.
GROOVE TO SUIT DORAN UNIV JOINT-PC.
1/8"
1/4"
ABT 5'-0"
2 REQD - PC V-244
ABT 5'-0"
2 REQ'D - PC. V-248
GROOVE TO SUIT DORAN UNIV JOINT PC. V-239
7/8 3/4 1"
DRILL & REAM FOR 3/8" FITTE BOLTS TO SUIT COUPLING-PC.
1/4"
ABT 15'-0"
2 REQ'D - PC. V-245
ABT 15'-0"
2 REQ'D. - PC. V-249
1" 3/4 7/8
DRILL & REAM FOR 3/8" FITTED BOLTS TO SUIT COUPLING - PC. V-240
GROOVE TO SUIT DORAN UNIV JOINT - PC. V-239
1/4"
ABT. 14'-0"
2 REQ'D. - PC. V-246
ABT. 15'-6"
2 REQ'D. - PC. V-250
1" 5/8
GROOVE TO SUIT DORAN UNIV. JOINT - PC. V-239
DRILL & REAM TO SUIT F 1/4" TAPER PINS & YOKE-PC.
1/4"
ABT. 4'-0"
2 REQD - PC V-247
ABT. 4'-0"
2 REQ'D - PC V-251

ISSUE FOR CONT. 241/312 - MATERIAL ORDERED ON 241-869-B/M V-32
ISSUE FOR CONT. 313/322-330/334 - MATERIAL ORDERED ON 313-869-B/M V-32

SCALE NONE

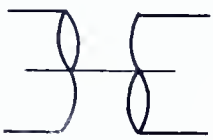
TITLE OPERATING RODS FOR F.O. TRANSFER SYSTEM

Print No. 1

PRINT NO. 1
INSTRUCTIONS

The title of blueprint No. 1, *Operating Rods*, automatically indicates that the shape of the rod stock is round and not square. For this reason there is no necessity for showing an end view of the rod, on this or on a similar blueprint.

The lengths of the rods are given as though the blueprint were full length. To avoid confusion, the rod is "broken" at a point between the ends. The "break" is indicated by the symbol shown below:



This sort of symbol always means a rod or shaft has been cut and it also shows the round shape of the rod. Such a "break" does not mean that the rod has actually been cut. The use of the symbol indicates the rod between the broken ends is plain, no holes or other cuts, and full size all the way.

"Drill and Ream for 3/8" fitted bolts to suit Coupling Pc V-240" means that V-240, the piece number of the coupling, has been drilled and that the rod must be drilled and reamed to suit the coupling. When reaming for a #6 tapered pin use a #6 tapered reamer. The size drill to use is found from the diameter of the small end of the tapered pin.

"Abt. 15'-0"" means that the rod is about 15'-0" long from end to end or "over all" as it is usually expressed.

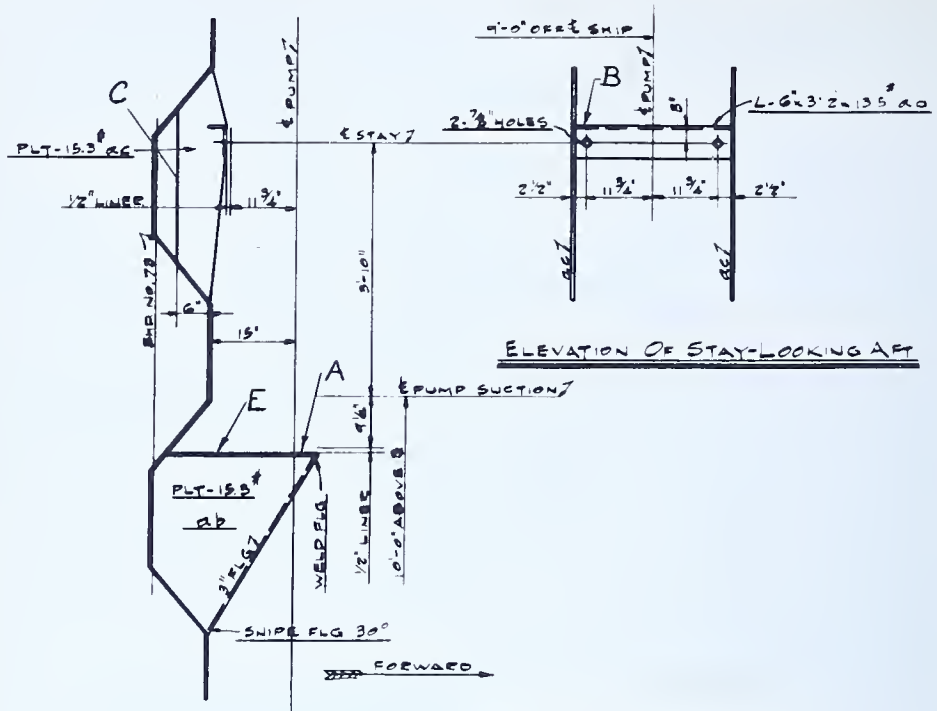
"Groove to suit Doran Universal print Pc V-239" means that a groove must be filed or milled in the rod to suit the hole that is drilled in the piece V-239.

The step in the end of any one of the rods shown is milled or hacksawed and filed to the dimensions given. The ends of the rods should be square with the outside diameter before the measurements are taken.

The letters "F. O." in the title mean Fuel Oil. The notation "Scale, none" means that the drawing or blueprint is not made to scale. Work to the dimensions. Never measure a blueprint.

PRINT NO. 1
QUESTIONS AND PROBLEMS

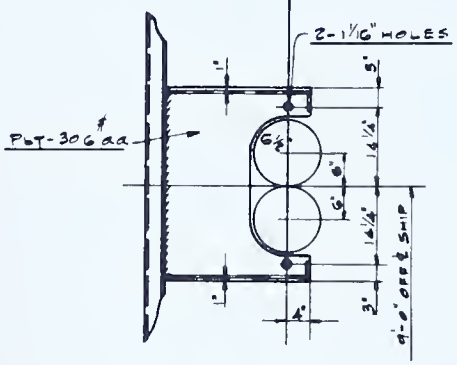
1. What is the diameter of the operating rod stock that is used to make the parts shown?
2. How many "stepped" rod ends are shown?
3. What size reamer is used to ream the taper holes in the rod ends?
4. How many different length operating rods are shown on this blueprint?
5. What does the abbreviation "Univ." mean?
6. Where should one get the information that will decide what size drill is to be used for drilling before reaming the tapered holes?
7. Why is the stepped end of the rod in the top figure on the blueprint reduced to 1-1/8" diameter?
8. Should the grooves in the ends of the rods be filed or drilled?
9. Explain the difference between a universal joint and a coupling.
10. How far is the face of the step from the outside diameter of the rod in the top figure?



ELEVATION OF STAY-LOOKING AFT

ELEVATION LOOKING OUTBOARD

USE DBL ¼ CONT WELD THRUOUT



PLAN OF FOUNDATION

FOUNDATION FOR FIRE & BALLAST PUMP – PORT SIDE ONLY

1-8	Mail 3	
11-21	-41.	
4-6	41M	3
7-12	41L	6
13-18	45	6
19-20	36	2
21-22	38	2
23	78	1
24	88	1
11-29	-41.	

FOR CONTRACTS

24
24

SCALE ½ IN = 1 FT

TITLE FOUNDATION FOR FIRE & BALLAST PUMP IN FORWARD PUMP ROOM

Print No. 2

PRINT NO. 2
INSTRUCTIONS

Blueprint No. 2 shows how the several members of a pump foundation welded to the bulkhead of a ship. It is the job of the outside inist to lay off and drill the holes shown.

Note the center line of the pump which extends from and through Plan of Foundation view to and through the Elevation Looking Out-d view. The letters "℄" at the upper end of the center line mean ter Line" on any blueprint. When beginning to lay out the work any job, always find or locate a center line from the blueprint then take all other measurements from the center line.

Sometimes the dimensions seem to be missing. Usually the dimen-s may be found by adding or subtracting certain dimensions which be given adjacent to the location of the missing dimension.

For example: Line "C" is 6" from the face of the corrugation in bulkhead. The face of the corrugation in the bulkhead is 15" from pump "℄". Therefore the edge represented by line "C" is 21" from pump "℄". Other similar dimensions may be found the same way.

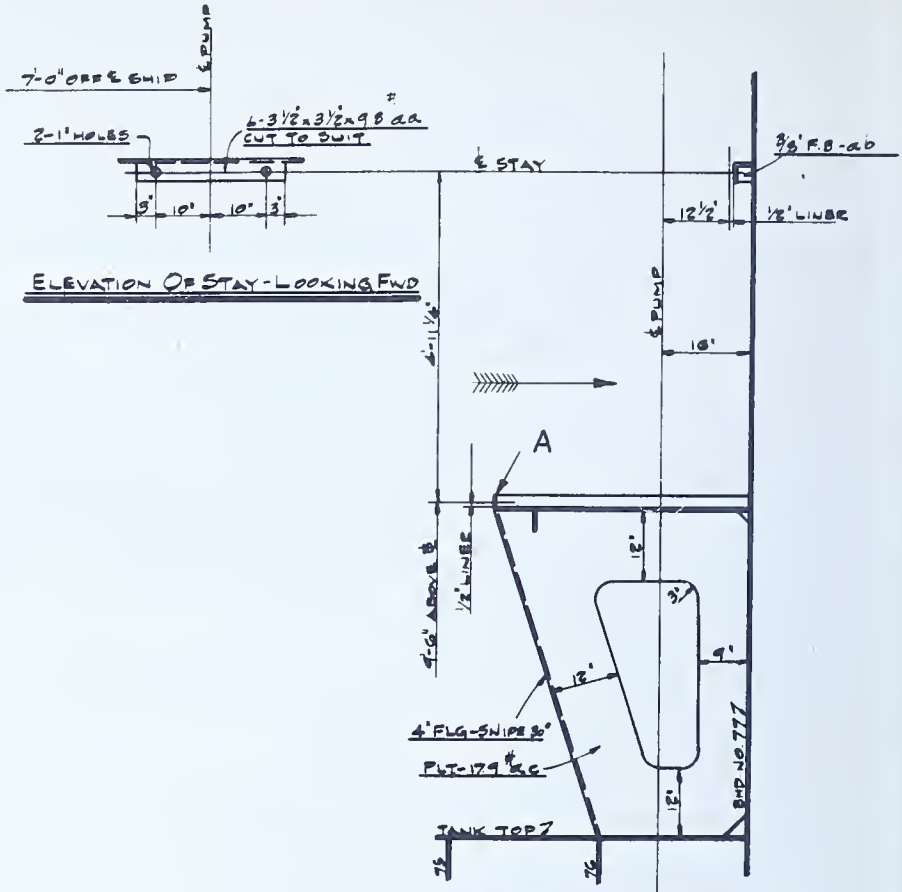
"DBL" means "double".
"Cont." means "Continuous."
"FLG" means "flange".
"ab" means "identification of plate" or "piece mark of plate".
"PLT" means "plate".
"BHD" means "bulkhead".
The symbol for "angle" is ∠ .
"aa" means "identification of plate" or "piece mark of plate".
"13.5#" means "thirteen and one-half pounds".

NOTE: The "13.5#" refers to a plate which is just thick enough to weigh 13.5 pounds per square foot of area. A piece of this plate ten feet square weighs 1350 pounds.

The notation "Port Side Only" means that the foundation is to be alled on the port side of the ship but that there is no foundation e installed on the starboard side.

PRINT NO. 2
QUESTIONS AND PROBLEMS

1. The view at the upper left is marked: "ELEVATION LOOKING OUTBOARD." Examine the blueprint closely and state whether the outboard direction is port or starboard.
2. Looking at the plan of foundation view, state how far the centers of the two large circles are from the forward face of BHD. No. 73.
3. What are the diameters of the two large circles in the foundation plan?
4. Are both circles the same diameter?
5. State the center to center distance of the two large circles in the Plan of Foundation view.
6. In the elevation Looking Outboard view, how far is the edge marked "A" from the center line of the pump suction?
7. In view, Elevation of Stay, looking aft, how far is edge "B" above center line of stay?
8. What is the center-to-center distance of two 7/8" holes in the elevation of stay view?
9. What weight plate "pc mark aa", is specified for the top of the shelf for the foundation?
10. What is the distance from the top of shelf "E" to the center of the stay shown in the Elevation of Stay Looking Aft?



1-3	MAIL	3
11-1	1-41	
4-6	23M	3
7-12	23L	6
13-18	25	6
19-20	36	2
21-22	38	2
23	77	1
24	88	1
11-2	9-41	

FOR CONTACTS

FOUNDATION FOR F.O TRANSFER PUMP-STBD. SIDE ONLY

SCALE ½ IN = 1 FT	TITLE FOUNDATION FOR F.O. TRANSFER PUMP IN FORWARD PUMP ROOM	A

Print No. 3

PRINT NO. 3
INSTRUCTIONS

Blueprint No. 3 shows the foundation for a fuel oil transfer pump the starboard side of the ship. The foundation is welded to the er face of bulkhead No. 77 and rests on the tank top. Longitudinals, bers 75 and 76 are partly shown in the Elevation Looking Inboard.

The outside machinist lays out the locations for the bolt holes drills them. Center lines are first located and the centers of holes are established and center punch marked. The sizes of the es shown on the blueprint appear to be the same. A close inspecns of the figures will show that there are three sizes of holes be drilled.

Notice that when a group of holes is to be drilled the same size t only one hole is marked but the total number of holes of that size indicated at the same place the hole size is given. For example: $1\frac{1}{2}$" holes means that there are 4 holes in the group and each hole to be drilled $1\frac{1}{2}$" diameter and the holes are drilled all the way ough unless there is a definite dimension given for the depth of hole.

In addition to abbreviations which were given on previous informan sheets, the following are shown on this blueprint.

"B" means "base line".

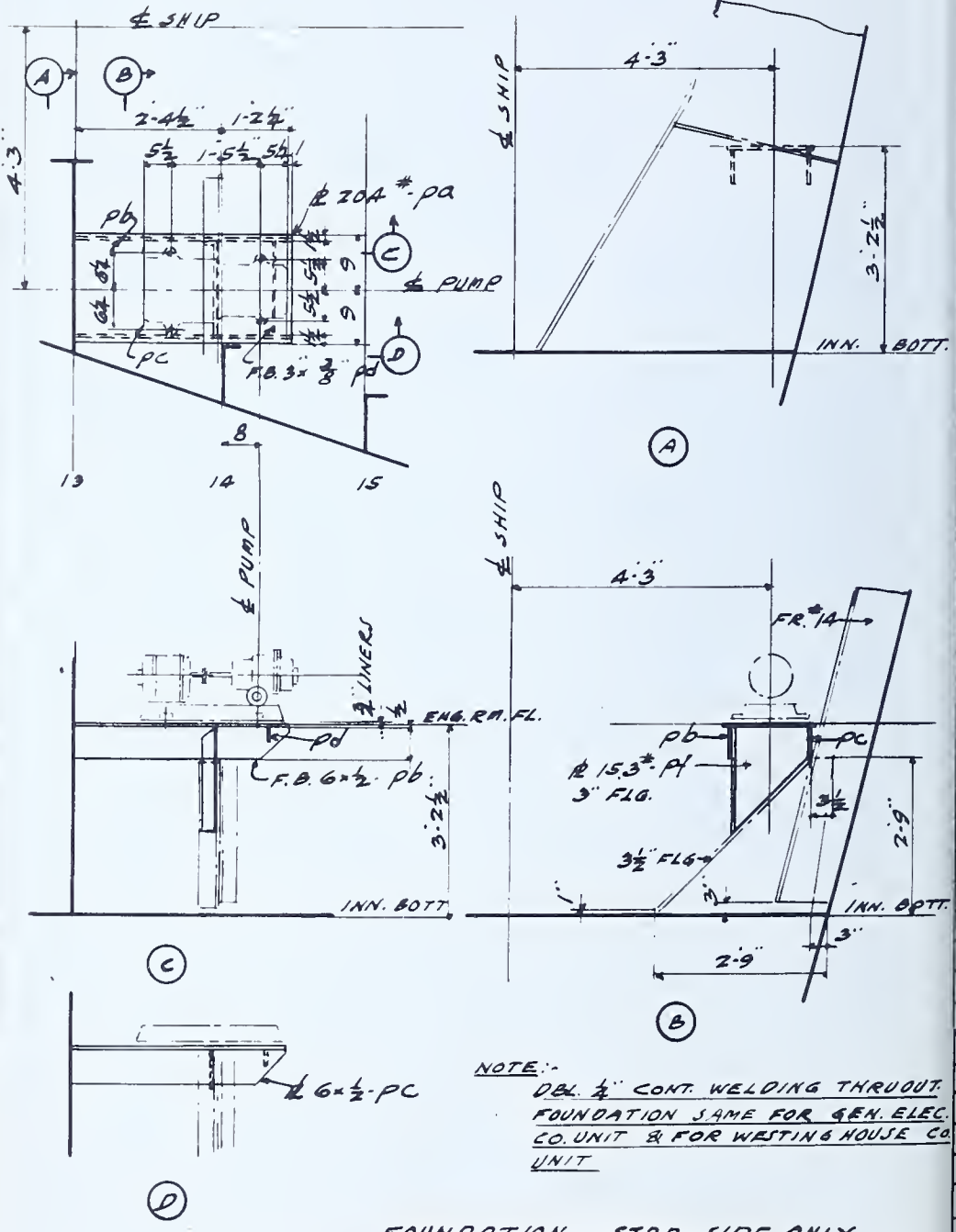
"af" means "identification of plate" or "piece mark of plate".

The notation "$\frac{1}{2}$" liner" means that dimensions are given to or from face of a $\frac{1}{2}$" thick piece of steel that is to be installed at the en location some time later. Allowance must always be made for such ers or other indicated plates.

"ad" means "identification of plate" or "piece mark of plate".

PRINT NO. 3
QUESTIONS AND PROBLEMS

1. Is the arrow, near the top of Elevation Looking Inboard, pointing forward or aft?
2. State the number of 7/8" holes in the foundation.
3. How many 1-1/4" holes are there in the foundation?
4. What is the distance, center to center, of the 1" holes in the stay?
5. On which side of the ship is the foundation located?
6. State the distance from edge "A" to pump center line.
7. What shape of stock is F. B.-4' x 3/8" add?
8. State the center of hole to center of foundation distance of the 7/8" holes in the plan foundation.
9. How far is the center line of these holes from the pump center line?
10. State the distance from the top of the 1/2" lines, inboard elevation to the base line of the ship.



NOTE:-
DBL. ¼" CONT. WELDING THRUOUT.
FOUNDATION SAME FOR GEN. ELEC. CO. UNIT & FOR WESTING HOUSE CO. UNIT

FOUNDATION - STBD SIDE ONLY

SCALE ½	TITLE FOUNDATION FOR REFRIGERATING & CIRCULATING WATER PUMP

Print No. 4

PRINT NO. 4
INSTRUCTIONS

Blueprint No. 4 shows a foundation for a circulating water pump. blueprint shows the side view, the end view, and the top view of pump in *phantom* outline.

The key letters in the small circles are for the guidance of the pfitter when he is installing the foundation plates and supports. outside machinist lays out the hole locations and drills them.

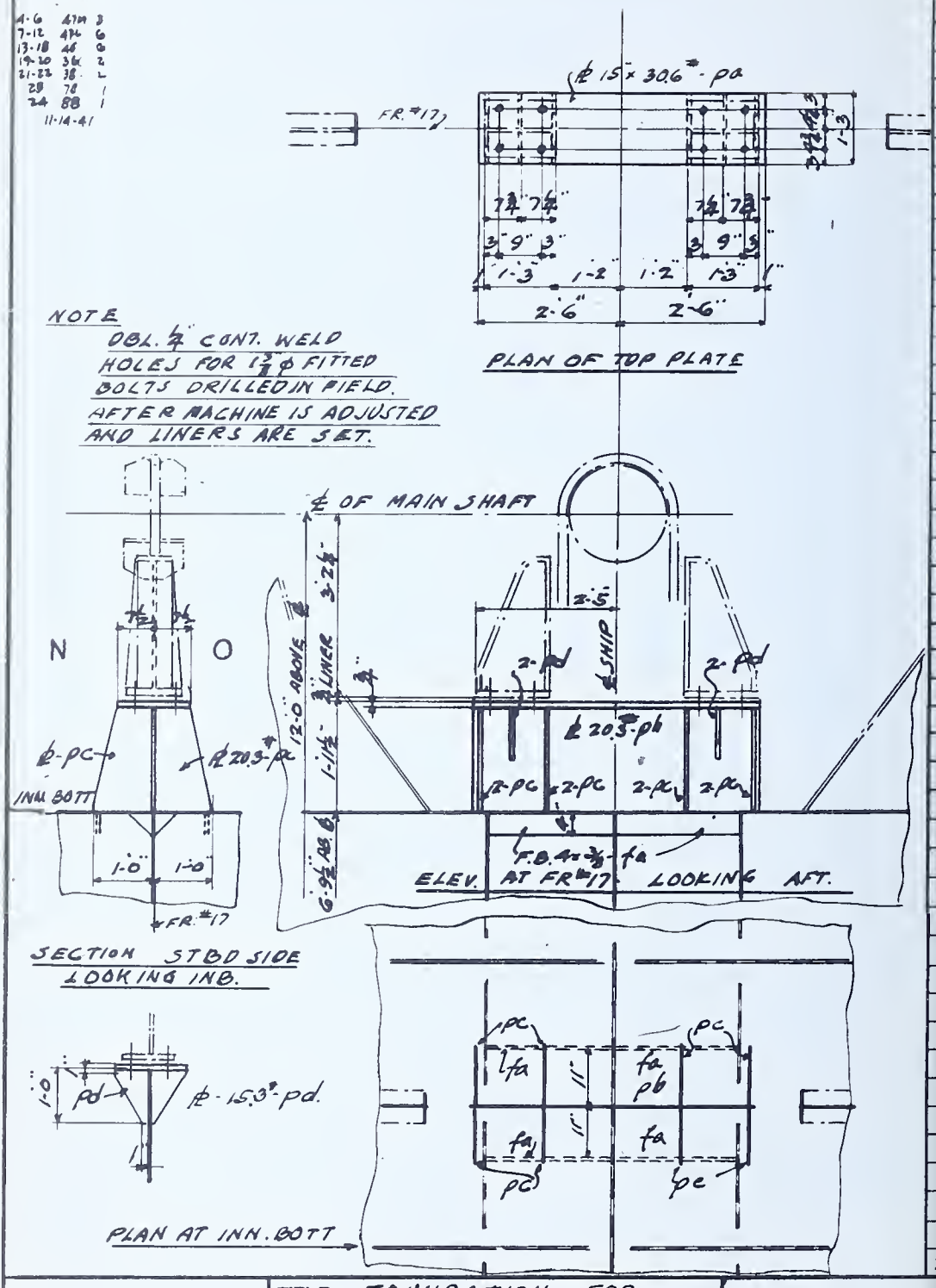
Measurements are taken from the ship center line as on other jobs. pump unit is placed, leveled, and chocked. The hole locations are n found through the holes in the base of the pump unit and worked on foundation top as they are drilled through the base.

Some additional abbreviations and symbols are used on this blueprint.

"pa" means "identification of plate" or "piece mark of plate".
"pd" means "identification of plate" or "piece mark of plate".
"Inn. Bott." means "inner bottom".
"pb" means "identification of plate" or "piece mark of plate".
"pt" means "identification of plate" or "piece mark of plate".
"pc" means "identification of plate" or "piece mark of plate".
"F.B." means "flat bar".
"Eng. Rm. Fl." means "engine room floor".
The figures "13,", "14", "15", in the upper left corner view are frame numbers.

PRINT NO. 4
QUESTIONS AND PRORLEMS

1. How many holes are shown through the base of the unit that has to be installed on the foundation?
2. State the distance from the center line of the ship to the center line of the pump base.
3. What is the distance from the inner bottom plate to the top of the pump foundation?
4. What is the chock or liner thickness under the pump base?
5. What size are the holes in the pump base?
6. Does the blueprint call for fitted bolts in the base and foundation?
7. What is the frame number opposite a point about midway between the pump motor and the pump?
8. Give the center to center distance, both ways, of the bolt holes in the foundation.


NOTE
OBL. ¼" CONT. WELD
HOLES FOR 1¾" ϕ FITTED
BOLTS DRILLED IN FIELD.
AFTER MACHINE IS ADJUSTED
AND LINERS ARE SET.
PLAN OF TOP PLATE
FR. #17
℄ OF MAIN SHAFT
℄ SHIP
INN. BOTT
ELEV. AT FR #17 LOOKING AFT.
SECTION STBD SIDE
LOOKING INB.
PLAN AT INN. BOTT
SCALE ½
TITLE FOUNDATION FOR
LINE SHAFT BRAKE

Print No. 5

PRINT NO. 5
INSTRUCTIONS

Blueprint No. 5 shows the foundation for the line shaft brake. All ensions are taken from center lines as before.

Study this blueprint carefully. The job is very simple to do. The e shaft brace unit is set on location according to the blueprint surements given. Chocks have to be fitted and holes drilled for the s which hold the unit to the foundation.

There are a few abbreviations and symbols not previously mentioned:

"STDB. SIDE LOOKING INB." means "Starboard Side Looking Inboard.

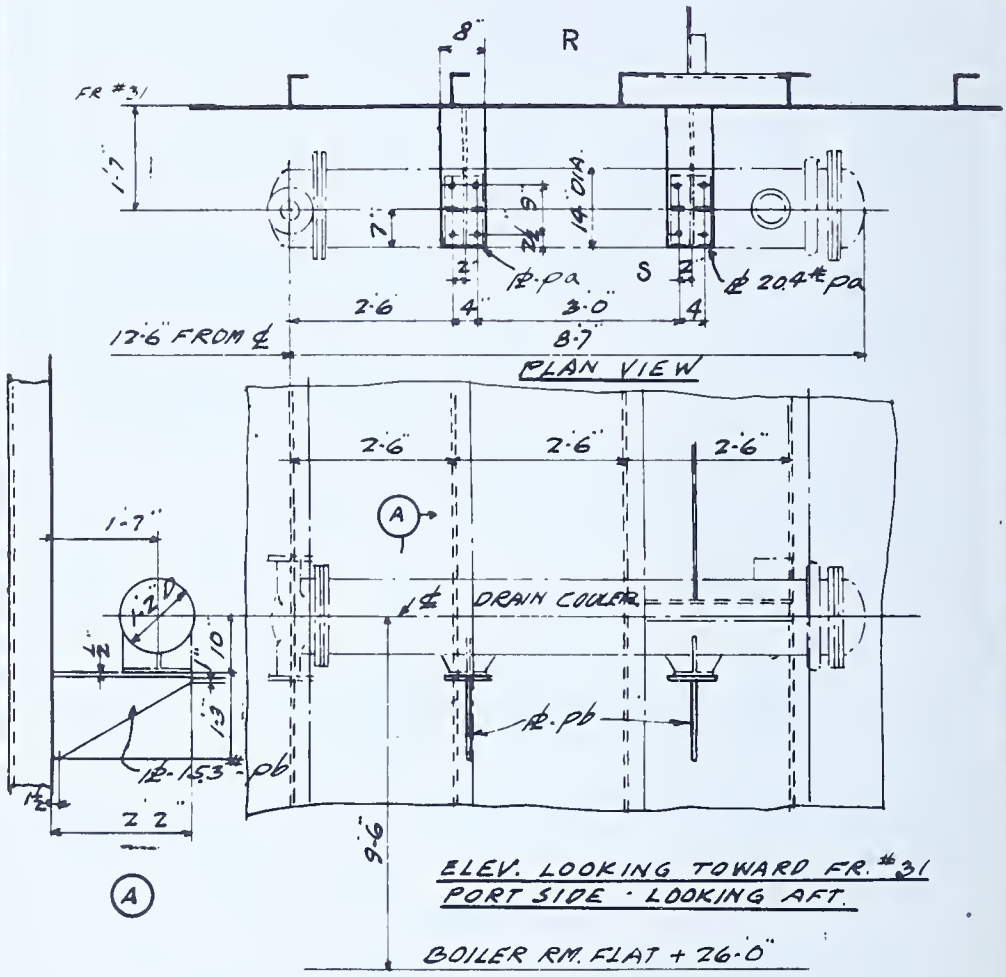
"fa" means "identification of plate" or "piece mark of plate".

"FB" means "flat bar."

"ph" means "identification of plate" or "piece mark of plate".

PRINT NO. 5
QUESTIONS AND PROBLEMS

1. Does the blueprint call for fitted bolts in the two welded side brackets?
2. What size bolt holes are drilled and reamed in the brackets and foundation?
3. On what center line is the foundation set?
4. How far is the center of the brake drum above the base line of the ship?
5. What thickness chock or liner is used under the base of the installation?
6. Which side of the section "Starboard Side Looking Inboard" is forward? N? or O?
7. What is the longest distance, center to center of any two bolt holes in the foundation?
8. What is the shortest distance, center to center of any two bolt holes in the foundation?



NOTES:-

DBL. ½" CONT. WELDS THRUOUT.
HOLES FOR ¾" ℄ FOUNDATION
BOLTS DRILLED IN FIELD
AFTER DRAIN COOLER IS ADJUSTED.

REV. 12/12/41 DRAIN COOLER
CHANGED FR. 1-3" TO 1-7"
FWD. OF FR. ℄ 31

FOUNDATION PORT SIDE ONLY

SCALE ½

TITLE: FOUNDATION FOR DRAIN COOLER

Print No. 6

PRINT NO. 6
INSTRUCTIONS

Blueprint No. 6 shows a foundation for a drain cooler. The cooler supported on two fabricated steel brackets which are welded to frame 31. The outside machinist lays out the hole locations and drills m.

All measurements are taken from center lines as before. The unit placed correctly, chocks are fitted, and the cooler is bolted down place.

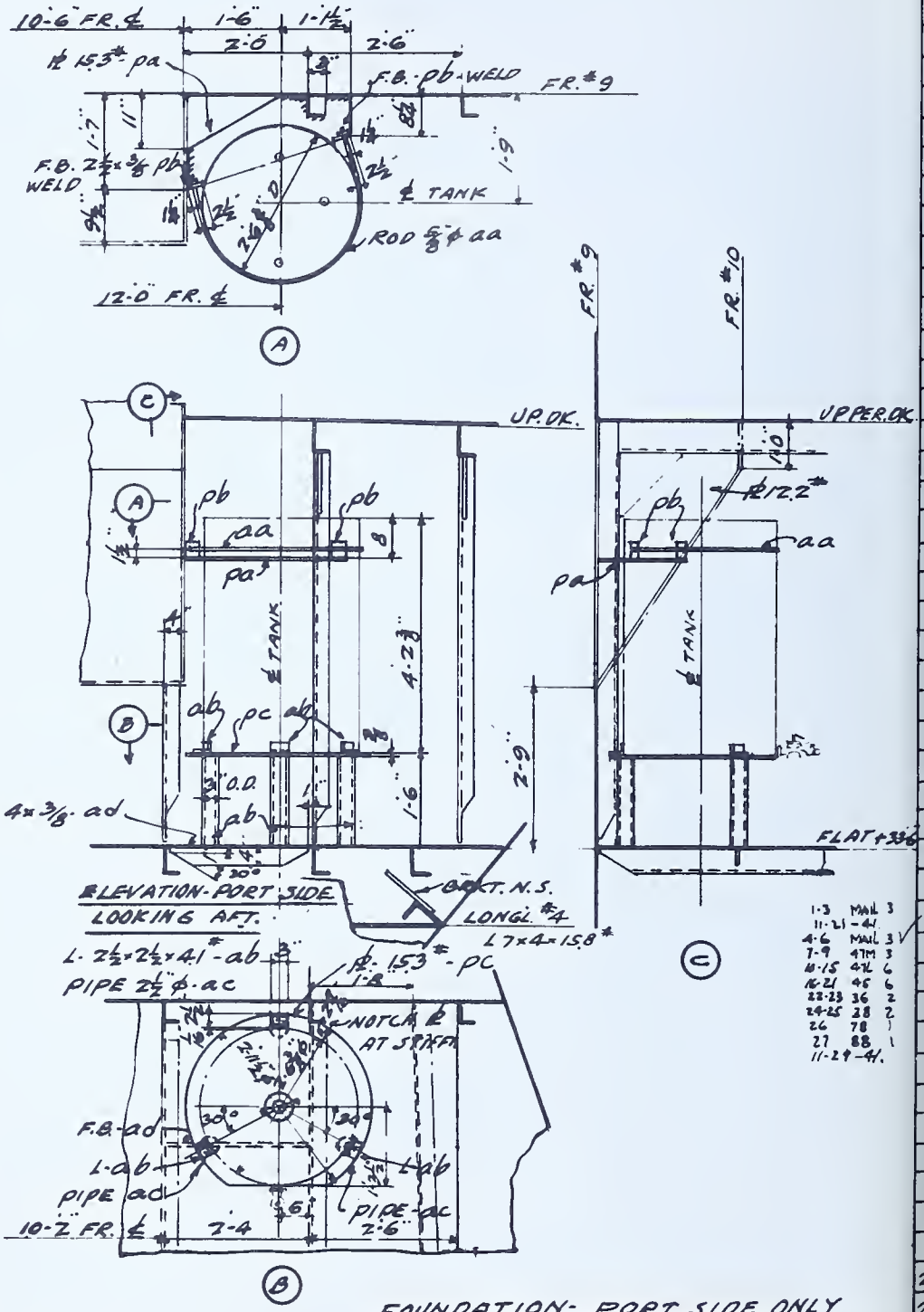
"Boiler Rm. Flat + 26'-0"" means "above base line".

The reference letters "A" and "A" are intended for the shipfitter n he is installing the bracket supports for the cooler. The letters icate the correct location for the bracket shown in the left-hand w.

"1'-2" D means "one foot and two inches diameter".

PRINT NO. 6
QUESTIONS AND PROBLEMS

1. What size holes are drilled and reamed for the drain cooler pedestals?
2. How many bolt holes are there in one pedestal?
3. What is the distance from frame number 31 to the center line of the drain cooler?
4. What is the thickness of the chock or liner between the pedestal and the foundation?
5. Give the center-to-center distance of the hole centers in the pedestal feet, parallel to frame number 31.
6. State the longest center-to-center distance between any two of the holes in the foundation, measuring parallel to the center line of the cooler.
7. What is the center distance of the cooler from the boiler room flat?
8. Which is the forward side of the plan view? R. or S.?



FOUNDATION- PORT SIDE ONLY

SCALE ½	TITLE FOUNDATION FOR 160 GAL KEROSENE TANK

Print No. 7

PRINT NO. 7
INSTRUCTIONS

Blueprint No. 7 shows a foundation for a 150-gallon kerosene tank. tank is installed to rest on three pieces of 2½" pipe 1'-5 5/8" g. The pipes are supported by the flat shown in the view at the ıt. See section C. Angle clips are placed at suitable intervals ınd the bottom of the tank on the supporting plate to secure the tank ›osition.

A rod around the top of the tank, shown in the top view, holds the of the tank securely. A plate is welded in the corner formed by ıe #9 and the bracket shown in the right-hand view. The bracket ex- ıs from frame #9 to frame #10. See section C.

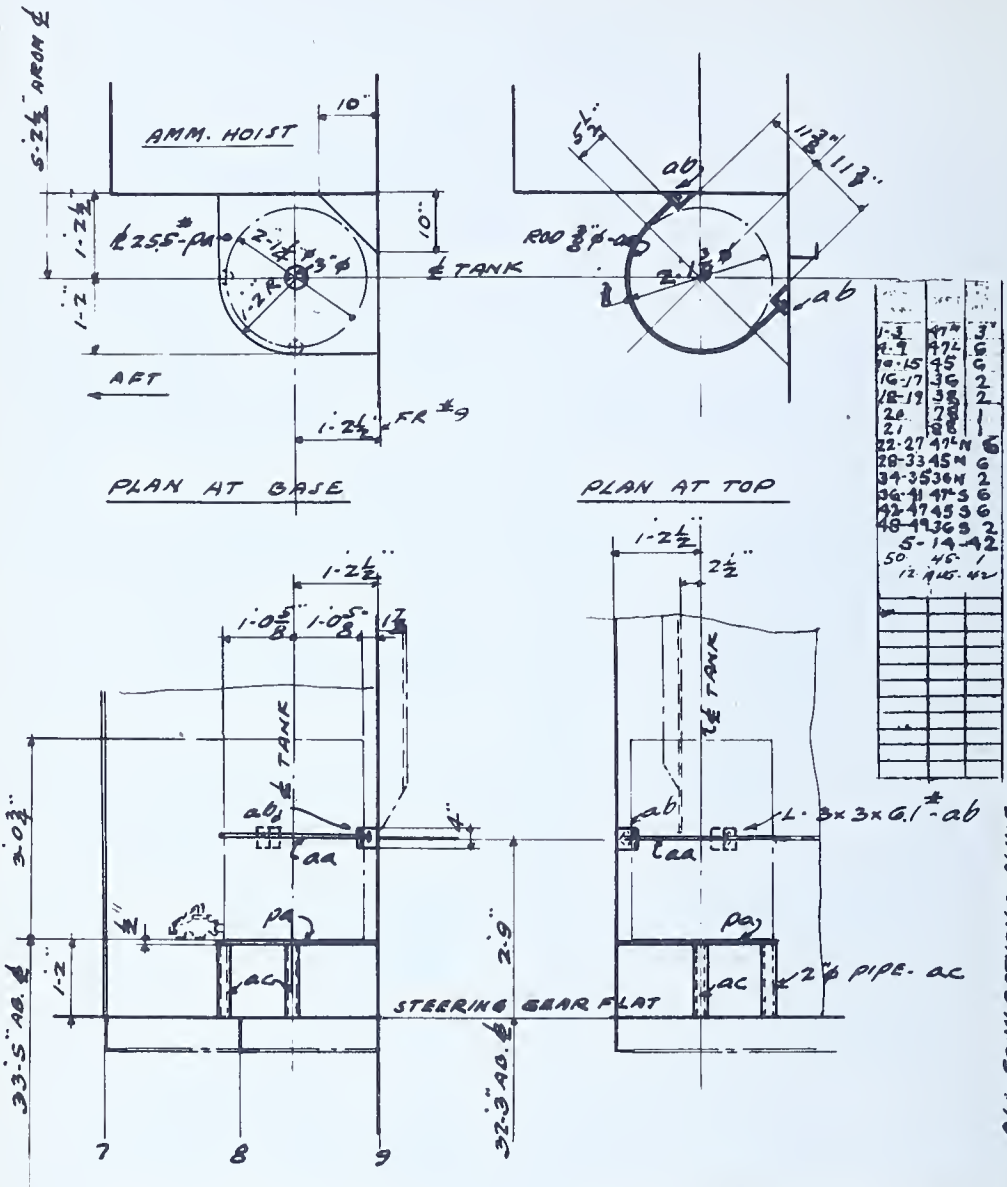
Angle clips are welded to the plate just mentioned and holes for rod around the top of the tank are drilled in the clips. A nut on ıer end of the rod clamps the tank tightly in place.

Some abbreviations and symbols not mentioned before are:

"Brkt. N.S." means "bracket on near side".
"longl." means "longitudinal".
"Up Dk." means "upper deck".
"stiffr" means "stiffener".
"L-ab" means "angle identification" or "piece mark of angle bar".
"10'-2" Fr. ℄" means "10'-2" from center line".
"O.D." means "outside diameter"
"L 7 x 4 x 15.8#" means "longitudinal #4 is an angle bar 7" x 4" x 15.8#".
Ⓐ— means a section taken through this way, looking the way the arrow points
Ø is a symbol for diameter.

PRINT NO. 7
QUESTIONS AND PROBLEMS

1. On Section A what is the diameter of rod holding the kerosene tank?
2. How far is the ℄ of Kerosene tank from the ℄ of ship?
3. How far is the kerosene tank from #9?
4. To what diameter must the rod be bent to take the tank?
5. What is the distance from the bottom of tank to the base line?
6. Which is the forward side of the Plan View?
7. What is the distance from the rod to the top of tank?
8. What is the distance from the flat to the rod?



GEAR OIL TANK

FOUNDATION - STBD. SIDE ONLY

SCALE 1/2

TITLE FOUNDATION FOR GEAR OIL TANK IN STEERING ENGINE ROOM

Print No. 8

PRINT NO. 8
INSTRUCTIONS

Blueprint No. 8 shows a foundation for a gear oil tank located in teering engine room. Notice the wording under each view which is ied to show the relationship of the views.

The plate under the tank is supported by pipes which are secured e steering gear flat.

The tank is held in place by one rod fastened around the middle. is a nut on either end of the rod to draw it tight through angle welded to the bulkhead.

Some additional abbreviations and symbols follow.

"33'5" AB.B" means "33'-5" above base line".
"Ø is a symbol for diameter.
"AMM" means "ammunition".
"O"" means "over all".

PRINT NO. 8
QUESTIONS AND PROBLEMS

1. On which side of the ship is the gear oil tank located?
2. How far is the ℄ of tank from the ℄ of ship?
3. How far above the steering gear flat is the rod located?
4. To what diameter must the rod be bent to take the tank?
5. What is the distance from Fr #9 to the ℄ of tank?
6. What is the distance from base line to bottom of tank?
7. What is the diameter of the rod?
8. On the sketch "Plan at Top" which is the forward side?

APPENDIX II

Shipyard Outside Machinist Terms and Definitions

-

A

ıft--Aft of; farther aft than.

ess Holes--Holes cut in the structure of a ship to permit entering or leaving various compartments.

ommodation Ladder--A portable ladder or stairway hung over the side of a ship to accommodate people who are boarding from, or disembarking to, small boats or a pier.

--Toward, at, or near the stern.

er--Nearer stern.

ermost--Nearest the stern.

er Body--A hull form aft of the midship section.

er Peak--The compartment in the narrow part of the stern, aft of the last watertight bulkhead.

er-Peak Bulkhead--The watertight bulkhead farthest aft.

er Perpendicular--A vertical straight line at, or near, the edge of the rudderpost.

Hammer--A hammer driven by compressed air for riveting; sometimes called an air gun or "gun".

Port--A circular opening or window through the side of the ship, or deck house, to admit light and air.

ıships--At or near the middle of the ship between stem and stern.

ıor--A heavy, hook-shaped device for holding a ship at rest in water. The anchor grips the ocean bottom and is fastened to the ship by a chain.

Angle Clip--A short piece of angle bar.

Angle Collar--A ring made of angle bar.

Anneal--To soften metal by heating and allowing it to cool slowly.

Aperture--The recess in which the propeller is located.

Apron Plate--A small plate at the prow of the ship to stiffen the top of the bulwark.

Assemble--To fit together the small parts of a larger member or unit and make so it complete.

Athwartship--Across the ship at right angles to the centerline.

Auxiliaries--Machinery supplementary to main propulsive units.

Awning Deck--A shade deck above another deck.

B

Ballast--Any weight or weights (usually sea water) used to keep the ship from becoming "top heavy" or to change her trim.

Ballast Tank--Watertight compartment to hold baslast.

Barnacles--Small marine growths that attach themselves in large numbers to the hull of a ship., often greatly retarding its speed.

Battens--Long strips of wood used in the mold loft for fairing lines; also, wooden protective strips in cargo holds; see hatch battens.

Beams--An athwartship member supporting a portion of a deck; also, the width of the ship.

Beam Knee--(See Brackets.)

Below--Below a deck or decks (corresponding to "down stairs").

Bending Rolls--The rolls of a large machine used to give curvature to plates.

Bending Slab--A large floor made up of heavy, perforated, cast-iron slabs arranged in a manner which permits bending frames, angles, etc.

Berth--The place where a ship lies at anchor or at a wharf; a place to sleep; a bunk; also, a specified small section of the hull structure.

Between Decks--The space between any two decks.

Bevel--The angle between the flanges of a frame or other member (When greater than a right angle, open bevel; when less, closed. Also, to chamfer.

Bilge--The curved section between the bottom and the side of a ship; the recess into which all water drains.

Bilge Blocks--Supporting blocks used under the bilge for support during construction or dry-docking.

Bilge Keel--A fore-and-aft member fitted to the outside of the shell plating along the bilge to prevent excessive rolling of the ship.

Bilge Pump--A pump for removing bilge water.

Bilge Strake--The course of plates at the bilge.

Bilge Water--Water (due to leaks, sweat, etc.) that collects in the bottom of the hull.

Bilge Well--A sump to which bilge water drains.

Binnacle--A case, box, or
containing a ship's c
adjusting magnets, and
for use at night.

Bitt--A vertical post to
mooring lines are made
a bollard.

Bitumastic--An elastic cemen
as a paint to protect

Boat Deck--A deck on which
boats are kept.

Body Plan--A drawing which
frame lines in elev

Boiler--A container in whic
is heated to form

Boiler Chocks--Stay braces
prevent fore-and-aft m
of boilers.

Boiler Foundation--A suppor
boiler.

Bollard--A single tie pos
bitt).

Booby Hatch--A watertight
ing over a deck openin
is used for a stair
ladder.

Boom--A long, round, heav
piveted at one end,
used for handling carg

Boom Rest--A support for a b
it is not in use.

Boom Step--A socket for the
the boom.

Bosom Piece--A short piece
riveted over a butt j
two angles, a butt s
angle bars; a splice

Boss--The curved, swelling
of the ship's hull ar
propeller shaft.

Boss Frame--A hull frame
shaped to clear the p
shaft tube.

Boss Plate--A shell plate
the curved portion of
where the propell
passes outboard.

Bow--The forward end of

Bracket--A triangular plate used to connect rigidly two or more parts, such as a deck beam and a frame, a frame and a margin plate, etc.

Braze--To heat and join by means of hard solder (spelter). This solder may be brass, bronze, or other alloys.

Breakwater--A braced guard plate which prevents solid water from sweeping the decks.

Breast Hook--A triangular-shaped plate extending horizontally across the bow behind the stem, stiffening the stringers and stem.

Bridge, Navigating--The deck from which a ship is navigated.

Bridge Deck--The deck on the superstructure amidships, the top deck of the deckhouse.

Brow--A watershed over an air port; a small, inclined runway to allow passage of trucks over a hatch coaming, or through a bulkhead door, etc.; sometimes portable.

Building Slip--The place where a ship is built; a shipway.

Bulb Angle--An angle shape which is reinforced at one toe.

Bulb Plate--A narrow plate reinforced on one edge.

Bulb Tee--A tee bar with toe of web reinforced.

Bulkhead--A vertical partition corresponding to the wall of a room, extending either athwartships or fore and aft. A steel partition in a ship.

Bulkhead Sluice--A small opening in a watertight bulkhead which can be opened or closed from the deck above.

Bulwark--The side of a ship above the weather deck.

Bull Riveting--Driving rivets by squeezing them with a high-powered air or hydraulic machine.

Bunker--A compartment used for the stowage of coal or other fuel.

Buoyancy--Ability to float; lifting power when immersed.

Butt--The joint formed when two parts are placed edge to edge.

Buttock--A distance from centerline determined by the section of the moulded surface with a vertical longitudinal plane.

Butt Strap--A small plate used to connect the two parts of a butt joint by overlapping each; a splice piece.

C

Camber--The athwartship rise or crown of a deck.

Cant Frame--A frame which is not square to the keel line.

Capstan--A revolving drum with a Vertical axis, used for heaving in lines.

Cargo--The freight carried by a ship.

Cargo Battens--Strips of wood used to keep cargo away from the steel hull.

Cargo Boom--A heavy boom used in handling cargo.

Cargo Hatch--A large opening in a deck which permits the loading of cargo into holds.

Cargo Port--An opening in a ship's side used in loading and unloading cargo.

Casing--Bulkheads enclosing a portion of a vessel, as the boiler room casing. Also a covering for parts of machinery.

Calk--To make a joint watertight.

Calker--One who calks.

Ceiling--Wood sheathing on the tank top, sides of a ship, and bulkheads; used to protect cargo.

Center Keelson--(See vertical keel).

Center Line--The middle line of the ship, extending from stem to stern.

Chafing plate--A bent plate used to minimize chafing of ropes, as at hatches.

Chain Locker--A compartment in the forward portion of ship in which anchor chain is stowed.

Chain Pipe--A pipe for passage of anchor chain from deck to chain locker.

Chain Riveting--Two or more rows of rivets spaced so that the rivets in one row are opposite those in an adjacent row.

Chain Stopper--A device which prevents anchor chain from running out. It is moved into position after the anchor has been dropped.

Chamfer--To cut off the sharp edge of a corner. To bevel.

Chart Room--A small room adjacent to the pilothouse in which charts and navigating instruments are located.

Chock--A heavy fitting through which ropes or hawsers are led, saddle or seat of wood or metal.

Chock, Boat--A cradle or support for a lifeboat.

Chock Roller--A chock with a sheave to prevent chafing of ropes.

Cleat--A fitting having two arms or horns around which ropes are made fast. A clip on the frames of a ship used to hold cargo battens in place.

Clinching Pan--A flat plate for clinching nails (Used in the mold loft.)

Coaming--The vertical boundary of a hatch or skylight.

Cofferdam--A narrow vacant space between two bulkheads, a double watertight bulkhead.

Collar--A flanged band or A welded plate used to a frame or beam penetr through plating.

Collision Bulkhead--The wate bulkhead nearest the b a ship; forepeak bulk

Companionway--A covered sta leading downward from a deck; a series of steps ing from the deck to a or saloon below; also space occupied by these

Compartment--A subdivision space or a room in a

Corrugated--Having a seri wrinkles or grooves ar so as to produce stiff

Corrugated Bulkheads--Bulk with corrugated plating eliminates the need fo welded siiffeners.

Counter--The overhang of the of a ship.

Countersink--To taper a ho a flush rivet or bolt.

Cowl--The hood-shaped top ventilator pipe.

Cradle--A form on which bows are assembled; the supp which a ship rests launching, a launching c

D

Davit--A crane arm used in ling small boats, life stores, gear, etc.

Dead Flat--A portion of a side or bottom where the ing has no curvature the midship portion of ant cross section (the lell middle body).

Dead Rise--The rise or upward of the bottom of a shi the keel to the bilge.

Dead Weight--The total wei cargo, fuel, water, s passengers and crew (an

effects) which a ship can carry.

:k--The part of a ship corresponding to the floor of a building.

:khouse--A shelter built on deck.

:livity--The inclination of shipways to provide for launching.

:p Tank--A deep compartment usually extending from tank top to lower deck.

'rick--A device for hoisting heavy weights, cargo, etc.

:--A tool for forming a rivet head (applied to rivet dies).

;placement--The total weight of the ship when afloat, including everything on board (equals weight of water displaced). This total weight is usually expressed in long tons.

--A small, bent metal fitting used in closing doors, hatch covers, manhole covers, etc.; a bent bar of round iron used in holding shapes on bending slab; any small, flat lug temporarily welded to structure as backing for a wedge.

.ly Bar--A heavy bar to hold against a rivet to give backing when riveting.

ıble Bottom--Compartments at the bottom of a ship between the inner and outer bottoms, used for ballast tanks, water, fuel oil, etc.

ıbling Plate--A plate fitted outside or inside of another to give extra strength or stiffness.

ag--The amount the stern end of the keel is below the bow end when the ship is afloat, but not on an even keel.

aft--The vertical distance from the lowest point of the ship in the water to water level.

Drift pin--A small tapered tool used in aligning holes in adjacent members.

Drop Strake--A strake discontinued near the bow or stern.

E

Erecting--The process of hoisting into place and bolting the various parts of a ship's hull.

Even Keel--A ship is said to be on an even keel when the keel is level, that is parallel to the surface of the water.

Expansion trunk--The raised portion of tank used on some oil tankers to allow for the expansion of oil when temperature rises.

Eye--The large hole in the stern frame which is bored out to take the stern tube liner.

Eye Bolt--A bolt the head of which is in the form of a ring or eye.

F

Fabricate--To make raw material ready for assembly or erection.

Face Plate--A narrow, stiffening plate welded along the edge of any web frame or stiffener.

Fairing or Fairing Up--Correctly lining up the structural members of a ship· assembling the parts of a ship so that they will be fair, that is, without kinks, bumps, or waves; bringing rivet holes into alignment.

Fair-lead--A fitting through which or over which a rope, line, etc., may be led so as to change its direction without excessive friction.

Fair water--Plate or casting used to preserve streamline flow past hull structure or propeller hub.

Fathom--Six feet.

Fathometer--A device to measure the depth of water by timing the travel of a sound wave from the ship to the ocean bottom and return.

Faying Surface--The contact surface between two adjoining parts.

Fender--A portable device made of wood or rope to protect a ship when bumping a pier; permanently installed dock extension which protects the hull of a ship in docking.

Fidley--Casing top over the boiler room.

Fidley Hatch--A hatch over the boiler room.

Flagstaff--Flagpole at the stern of the ship; ensign staff.

Flange--A part of a plate or shape at, or nearly at, right angles to the main part; to bend over to form an angle.

Flare--The sudden widening of the shell at the top near the bow.

Flat--A small partial deck (built level) without curvature.

Floor--The lower portion of a transverse frame, usually a vertical plate extending from center line to bilge, and from inner to outer and bottom.

Fore and Aft--In line with the length of the ship, longitudinally.

Fore-and Aft Gangway--A walkway between deckhouses at or near the center line of the ship.

Fore Body--A hull form forward of the midship section.

Forecastle--The forward, upper portion of the hull. It is sometimes used as the crew's quarters.

Forefoot--The part of the keel which curves and rises to meet the stem.

Forepeak--The large compartme tank in the lower part bow of the ship.

Forepeak Bulkhead--Collision head; bulkhead nearest

Forging--Steel worked to sp shape by hammering whil hot.

Forward--Near, at, or toward bow of the ship.

Forward Perpendicular--A ver line through the interse of the stem with the water line.

Foundations--Supports for bo engines, and auxiliary inery.

Foundations, Auxiliary--Sup for small machinery, su winches, condensers, hea etc.

Frames--Ribs forming the ske of a ship.

Frames Continous--Frames co ing side frames and fl

Frame, Side--Inside frames connection to the shell ing.

Frame Spacing--The fore-ar distance between adj frames.

Frame, Web--A heavy side or tinuous frame, made wi plate for extra stiff

Freeboard--The vertical di from the upper water deck to water line, wh ship is fully loaded.

Freeboard Mark--(See Pli mark).

Freeing Port--A hole throu bulward to provide drainage of water fr deck.

Funnel--A smokestack of a ve

Furnace--A heater or large for heating plates or for bending; to bend by ing in furnace.

G

ey--A cooking room or kitchen.

ey Dresser--A cook's work table.

anizing--Coating metal parts with zinc for protection from rust.

way--A passageway, a ladder, or other means of boarding a ship.

oard Strake--The course of plates next to the keel of a ship.

et--Packing of canvas composition, or other material, used in making a tight joint.

er--Fore-and-aft stiffening member for deck or bottom shell.

h--The transverse distance around the midship section.

Rods--Bent rods welded to bulkheads or the ship's side to form a ladder.

ing--Light platform or walking built up of metal bars, used for access to machinery.

met--A soft ring used under a nut or bolthead to maintain watertightness.

s Tonnage--A figure obtained by dividing the total volume of the ship, in cubic feet, by 100.

nd Ways--Timbers secured to the ground under the hull on each side of the keel. When the ship is launched, it slides down the ground ways into the water.

geons--The bosses on the stern post drilling on which the rudder swings.

ale--The junction of the deck and the shell at the top of the sheer strake.

ale Bar--Angle iron which connects stringer plate and shell plates. (Riveted work.)

Gyro compass--A mechanical compass operated by means of a gyroscope. This compass indicates true north rather than magnetic north.

Gyro Repeater--An apparatus to show the reading of the gyrocompass at a distance from the main gyroscope equipment.

H

Hatch--An opening in a deck for loading or unloading cargo, etc.

Hatch Battens--Flat bars which are wedged against hatch coamings to secure tarpaulins.

Hatch Beam--A portable beam used to support wooden hatch covers

Hawse Pipe--Casting, or castings, through the deck and the side of the ship at the bow for passage of anchor chain.

Hawser--A large rope used for towing and mooring.

Heeling--The inclination of a vessel to one side.

Hogging--Straining of the ship which tends to make the bow and stern lower than the middle portion.

Hold--The inside of a hull; cargo space.

Hold Beams--Structural members placed in a hold, similar to deck beams, but having no plating or planking on them.

Holder-On--Ore who "backs up" or "holds on" the head of a rivet while the point is being "driven", or upset.

Horn--To line or square up; also, psrt of a cleat.

Hull--The body of a ship, including shell plating, framing docks, and bulkheads.

I

I-Beam--A structural shape with a cross section resembling the letter I.

Inboard--Inside of the ship; toward or nearer the center line.

Inboard Profile--A drawing of the longitudinal section at center line of ship.

Inner Bottom--Plating forming the upper surface of the double bottom. Also called tank top.

Inner Shell--A plated surface or "shell" inside the outer shell plating, used as additional protection in case of collision or other accidents. The space between the inner and outer shells is often used as a storage space for liquid ballast or cargo.

Inserted Packing--Canvas strips soaked with red lead and placed between connections that cannot be calked successfully otherwise; stop waters.

Intercostal--Made in separate parts between frames, beams, etc.; the opposite of continuous. (Floors are continuous; longitudinal girders are intercostal in most cargo vessels.)

Isherwood System--A system of building ships in which the main framing is longitudinal (or fore-and-aft), instead of transverse as in ordinary ships.

J

Jack Staff--A flagstaff at the bow of a ship.

Joggle--An abrupt bend or offset in a plate, bar, or frame to eliminate the use of liners.

K

Keel--The principal fore-and-aft-member of a ship's frame. The keel runs along the bottom, connects the stem and helps to support the frames of the ship which are attached to it.

Keel-Blocks--Heavy Blocks support the keel of the during construction.

Keel, Flat--The bottom-shell on the center line o ship.

Keelson, Side--A fore-and member similar to the ve keel and placed on each of it.

Keel, Vertical--Vertical used as reinforcement fo keel, often called c keelson.

King Post--A stub mast, out from the center line, us carry cargo booms; king often serve as ventila

Knot--A tie in a line; a nau mile (about one and seventh statute miles.)

Knuckle--A sharp bend in a pl shape.

Knuckle Plate--A plate bent t a knuckle.

L

Ladder--Inclined steps, used ship instead of "sta

Lap--A joint in which one overlaps the other, avoiding the use of a strap; also, the amou overlap.

Launching--The operation of p a hull in the water by ing it to slide down on g skids called launching

Laying Out--Marking plat shapes for shearing, pun etc.

Lazarette--A space between used as a storeroom.

Length Between Perpendicular length of a ship measure the forward perpendicu the after perpendicular

ngth Over All--The length of a ship measured from the extreme forward end to the aftermost point of the stern.

ft--To make a template from measurements taken from the job.

ghtening Hole--A hole cut in a member to reduce its weight.

mber Hole--A small hole cut in a plate near the bottom to permit the passage of water.

ner--A flat or tapered strip of steel placed under a plate or shape to bring the member in line with another which it overlaps. A filler.

nes--The form of a ship as represented by its moulded surface.

st--To lean over to one side.

ad Water Line--The Line of the surface of the water on a ship when it is loaded to the designed draft.

ftsman--A mold-loft worker who lays down ship lines and makes templates.

gitudinal--A shell, deck, or bulkhead stiffener running fore and aft.

g pad--A projection on deck with a hole for fastening a block for a lead.

M

gnetic Compass--A device which indicates the direction of magnetic north by means of a magnetized needle (or needles) which is attracted towards the Earth's magnetic pole. Magnetic north is not to be confused with true or geographical north.

Main Deck--Usually the deck immediately below the shelter or weather deck.

Manhole--A hole cut large enough for a man to go through into a compartment, tank, etc.

Margin Plate--The outboard row of inner-bottom plating that joins the shell plating at the bilge.

Marker--A brass pipe dipped into paint for marking rivet holes.

Marlinespike--A pointed, tapering tool which is used in separating strands of rope or cable in splicing.

Mast--A long, heavy spar, placed nearly vertical on the center line of a ship.

Mess Room--A dining room for officers or crew.

Midship--At or near the middle point of the length of a ship.

Midship section--A vertical cross section through the ship, midway between the forward and after perpendiculars.

Mold Loft--A shed or building with a large, smooth floor on which the lines of a ship can be drawn to full scale.

Mooring--Securing a ship in position by several lines or cables so that it cannot move or swing; anchoring.

Mooring Pipe--A casting which prevents chafing of mooring lines that pass through bulwark plating.

Mold (or Mould)--A light pattern of a part of a ship; usually made of thin wood or paper. It is also called a template.

N

Net Tonnage--A figure obtained by making a deduction from the gross tonnage for space not available for carrying cargo.

O

Oakum--Untwisted fibres of old rope treated with a composi-

tion of resin and pitch. It is used to fill the seams of wooden decks.

Offset--To move out of line or position.

Offsets--A table of moulded dimensions for water lines, decks, etc.

Oiltight--Sealed by welding or calking to prevent oil leakage. (Closer rivet spacing is required than for water tight work.)

Old Man--A rig for holding a drilling machine.

On Board--On or in the ship.

On Deck--On the upper deck; in the open air.

Outboard--Away from the center line, toward the side of a ship.

Overboard--Outside; over the side of a ship; into the water.

Overhang--That portion of the bow or stern of a ship that projects over the water beyond the water line.

Oxter Plate--Bent shell plate which fits around the upper part of the sternpost; also called tuck plate.

P

Packing--Material which is placed between plates or shapes to make them watertight; wooden blocks and wedges which support a ship on the sliding ways; spacers.

Pad Eye--An eye located on deck for fastening cables; on the hull, and attachment for hanging a block and fall for lifting propeller or rudder.

Palm--Flattened top portion of rudderstock (for bolted connection); also, a flat surface at the end of a strut or stanchion.

Panting--An in-and-out mov of plating; to pulsa throb. Panting may be by the lift and fall ship in a seaway, or gine vibration.

Peak--A narrow compartme either end of a vessel.

Pelorus--An instrument use taking sights; simila compass, but without ma needles.

Pillar--A vertical member or which provides suppor deck girder. (It is termed a stanchion.)

Pilothouse--A wheelhouse; closed place which sh the main steering wheel trols, engine-room tele etc.

Pintle--A pin on which a hinges.

Pitch--Spacing; as of rive gear teeth.

Planking--Wood covering for etc.

Plating--The plates of a h deck, a bulkhead, etc.

Plimsoll Mark--A mark plac the side of the ship to cate the maximum allo draft.

Pontoon Hatch Cover--A steel shaped member sometime in place of hatch be close in a cargo hatch.

Poop--The after, upper port the hull, often conta the steering gear.

Poop Deck--The first deck the shelter deck at the end of a vessel.

Port--A harbor; an opening lide of a ship; the le side of a ship (as the looks toward the bow.)

Porthole--A circular open the side of the ship. port.)

ile--A side elevation of a ship's form.

eller--A rotating device which drives a ship through the water.

eller Post--The forward post of the stern frame, which is bored for the propeller shaft.

eller Shaft--Rotating bar by means of which the engine turns the propeller.

Q

ters--Living or sleeping rooms.

R

et--A depression or offset in an edge of material designed to receive some other adjoining part; as for example, the rabbet in the stem to take the shell plating.

--The upper rounded edge of the bulwarks.

--The aft slope of a mast, kingpost, or stack.

ing--Enlarging a rivet hole by means of a revolving, cylindrical, slightly tapered tool with cutting edges running along its sides.

rse Frame--An angle bar or other shape riveted to the inner edge of a transverse frame as reinforcement.

and--A fore-and-aft wooden strip or heavy batten which is used temporarily to align the transverse frames after erection.

ing--Ropes, wire ropes, lashings, masts, booms, etc.; also, the handling and placing of heavy weights and machinery on board the ship.

t--A short steel bolt used to fasten two or more members together by passing the shank through a hole in each piece and then hammering or pressing the plain end while red hot so as to make a second head.

Roll--To impart curvature to a plate; also, the motion of the ship from side to side, alternately raising and lowering each side of the deck.

Roller Chock--(See Chock Roller.)

Rose Box--A screen or strainer placed around the end of a bilge suction pipe.

Rudder--A flat structure of wood or metal attached upright to the sternpost (or in single-screw vessels, to the rudderpost) of a vessel by hinges or pintles and gudgeons, so that it can be turned, as by a tiller, causing the head of the vessel to turn in the same direction because of the resistance offered to the water by the rudder.

Rudderpost--The after post of the stern frame. This vertical post supports the rudder and is also called the sternpost.

Rudder Stock--The shank of the rudder which extends through the shell to the steering engine.

Rudder Stop--A lug to limit the swing of the rudder.

S

Sagging--A straining of the ship which tends to make the middle portion lower than the bow and stern.

Samson Post--A heavy, vertical post which supports cargo booms; king post.

Scantlings--The dimensions of various shapes.

Scarf--To thin out or taper a corner or edge of a piece of material to make a lap joint. A joint in a stem, bar keel, or stern frame.

Screen Bulkhead--A bulkhead usually placed between the engine room and the boiler room. This bulkhead is fireproof, dustproof, and gastight.

Scupper--A deck drain.

Scupper Pipe--A pipe which drains water from scuppers through the side of a ship.

Scuttle--A very small hatch; a manhole.

Scuttle Butt--A container for drinking water.

Sea Chest--A compartment through which sea water is admitted or discharged.

Seam--A riveted or welded, plate-edge connection. A riveted seam overlaps; a welded seam may or may not overlap.

Set--Metal mold or template for use on bending slab.

Set Iron--A bar of soft iron used on bending slab to give shape of frames.

Shaft Alley--A casing (large enough in which to walk) covering the propeller shaft and extending from engine room to after peak.

Shaft Tunnel--(See Shaft Alley.)

Shape--A bar of constant cross section, such as a channel, T-bar, angle bar, etc.; also, to impart curvature to a plate or other member.

Shear Line--A line at which a shearing cut is to be made.

Shears--A large machine for cutting plates and shapes.

Sheer--Curvature of deck in a fore-and-aft direction as seen in profile (See Part I- Information Sheet 4.)

Sheer Plan--A side elevation of a ship's form; a profile.

Sheer Strake--The top full course of side shell plating.

Shell Expansion--A plan s
details of all shell
and shell longitudinals
tudinals would appear
tankers.

Shell Landings--Point on the
where the edges of
plates are to be l

Shell Plating--The plates
the outer skin of th

Shelter Deck--A continuous
structure deck above t
board deck.

Shore--A temporary brace

Sight Edges--Visible ed
plating (outside sh
above decks.)

Skeg--The lower portion of
frame which projects
is level with the ship
and is welded to th

Skylight--An opening in a
give air and light
compartment below it.

Sliding Way--That part
launching way which mo
the ship when it is l

Slop Chute--Chute for dump
bage overboard.

Sounding Pipe--A vertic
in an oil or water
means of which the d
liquid in the tank
measured.

Spar--A long, round membe
as a mast or a boom;
the rigging.

Stability--The tendency o
to remain upright.

Staging--Planks or scaf
from which shipbuild
on the sides or un
decks of a ship.

Stanchion--A piller or
post for supporting
etc.

Stapling--Collars, forg
angle bars, which fi

continuous members passing through bulkheads or decks, to insure watertightness.

'board--The right-hand side of a ship, as the observer looks from aft forward.

'--A guy line.

ler--A right extending into an adjoining strake, as at the end of a drop strake.

ring Gear--The apparatus for controlling the rudder and steering the ship.

--The forging, casting, or plating forming the extreme bow of the ship and extending from the keel to the fore-castle deck.

--To set in place (as applied to a mast); also, a socket for the end of a mast; a support for the fixed or "hinged" end of a boom.

n--The after or rear end of the ship.

n Frame--A large casting or forging attached to the after end of the hull to form the ship's stern. It includes rudderpost, propeller post, and aperture for the propeller.

n Tube--A long bushing or berring through the stern to support the end of the propeller shaft.

ifener--An angle bar, T-bar, channel, etc., used to stiffen the plating of a bulk-head or other member.

cl;—A support for a propeller shaft bearing in the shaft alley. A foundation, etc.

o Water--Canvas and red lead, or other material, fitted between two metal parts to make a watertight joint.

c age--A support or fastening for any gear, as an anchor stowage or a boat stowage.

Strake--A fore-and-aft course or row, of shell or other plating.

Stringer--A fore-and-aft member used to give longitudinal strength. Depending on location, these are called hold stringers, bilge stringers, side stringers, etc.

Stringer, Deck--The strake of deck plating which contacts the shell.

Stringer Plate--A deck plate at the outboard edge of the deck connected to the shell of a ship with an angle or a welded joint.

Strongback--A supporting girder for a hatch cover; a rig used in straightening bent plates; a bar for locking cargo ports.

Strut--A support for a propeller tail shaft (used on ships with more than one propeller)

Superstructure--Deck houses, etc., which are located above the shelter deck.

Swash Plate--A baffle plate in a tank which prevents excessive surging of a liquid.

T

Tail Shaft--A short section of the propeller shaft extending through the stern tube and carrying the propeller.

Tank Top--The plating over the double bottom.

Tarpaulin--A waterproof canvas used for covering for hatches.

Taut--Drawn tightly, i.e.,"stretch a line taut.

Tee-Bar--A structural shape with cross section resembling the letter T.

Telegraph--A mechanically or electrically operated means of signalling from the bridge to the engine room, etc.

Template--A mold or pattern.

Thrust Bearing--A bearing or block to resist end thrust. A bearing on the propeller line shaft which relieves the engine from the driving force of the propeller.

Thwart--A seat in a lifeboat.

Tiller--An arm attached to the rudder head for operating the rudder.

Transom--The main frame at the rudderstock (cant frames usually radiate from the transom frame).

Transverse--Athwartships; across the ship; in a port and starboard direction.

Transverse Frames--Athwartship members forming the "ribs" of the ship.

Trim--To shift ballast; to cause a ship to change its position in the water; drag.

Trunk--A small casing passing through a deck, such as is used for ladders or ventilation.

Tumble Home--The inboard slant of a ship's side above the bilge.

U

Uptake--The connection between the boilers and the smokestack.

V

Vertical Keel--A row of vertical plates extending along the center of the first plate keel. It is sometimes called the center keelson.

Voice Tube--A large speaking tube.

W

Water Line--Any one of certain lines of a ship parallel with (and at various heights above) the base line. In half-breadth plans the water lines are smooth curves showing the shape of the sh profile plans they ar jected as straight l

Watertight--So riveted, c or welded as to preve passage of water.

Waterway--A narrow passage the edge of a deck for age. A gutter.

Ways--Timbers on which a s built and from which launched into the w (See Launching.)

Weather Deck--A deck expos the weather.

Web--A thin, stiffening mem smme steel shapes, such connecting plate betwe two legs of a channel connecting web of an I

Web Frame--A frame with a web.

Welding--Fusing together more members with an el arc or by other means.

Well--A cofferdam or a sump double bottom.

Wheel--A nickname for the eller; steering gear c

Winch--A small hoisting engi in pulling lines or h cargo.

Windlass--A machine used t the anchors by winding anchor chain.

Wind Scoop--A device used to air into a compartment ship.

Z

Zee-Bar--A structural sha a cross section res the letter Z.

Zigzag Riveting--Two or m of rivets spaced so t rivets of the row ar from these in the ne

APPENDIX III

Abbreviations Used by Shipbuilders

-After end (rear or stern)
--Alteration
--Ammunition
.--After Peak
.--After perpendicular
--Auxiliary
.--Bulb angle
--Between
--Bevel
--Bulkhead
[--Bracket
Base line
.--Bolted manhole cover plate
--Bill of material
--Bottom
--Buttock
Channel or channels
or ℄--Center line
--Cofferdam
--Countersink holes
-OS--Countersink other side
P'T--Compartment
)--Condenser
--Connection
.o C.--Center to center
C.--Closed roller chock
C.--Closed towing chock
--Centers
K.--Center vertical keel
DIAM--Diameter
--Doubler
--Dimension
DK--Deck
or DWN--Down
-Door
--Elevation
--Expanded metal
--Engine room
-Exhaust
-Expanded
--Finish
--Flat bar
-Blower--Forced draft blower
FDK--Forecastle deck
FE--Forward end (front or bow)
F.K.--Flat keel
FLG--Flange
F.O.--Fuel oil
FOCS'LE--Forecastle
FOR'D or FWD--Forward
FND--Foundation
F.P.--Forepeak or forward perpendicular
F.P.--Flanged plate
FR--Frame
F.W.--Fresh water
GALV--Galvanize
GEN--Generator
GIR--Girder
H-Hull or H--Beam
HLS--Holes
H.P.--High pressure or horse-blower
H.R.--Half round
I--"I" beam
IB--Inboard
I.D.--Inside diameter
INV--Inverted
KP--King post
L--Angle, locker, length, or longitudinal
L.B.P.--Length between perpendiculars
LBS or #--pounds
L.C.A.--Length over all
L. or LONG--Longitudinal
L.P.--Low pressure
LUB OIL--Lubricating oil
L.W.L.--Load water line
MAX--Maximum
MIN--Minimum
M.L.--Molded (or Moulded) line
MLD--Molded (or Moulded) line
M.P.--Mooring pipe
N--Near
NO--CSK--No countersink
N or #--Number
N.W.T.--Non-watertight

OB--Outboard
O.C.--Open chock
O.D.--Outside diameter
OPP--Opposite side
O.S.--Other side
O.T.--Oiltight
O.T.H.--Oiltight hatch
P--Port
P.C.--Pitch circle
PDK--Poop deck
PLT or ℙ--Plate
PLTG--Plating
PM--Pitch mark, check mark, or spot
R or RAD--Radius
R.C.--Roller chock
REQ--Required
RIV--Rivet
R.O.T.M.H.--Raised oiltight manhole
R.P.M.--Revolutions per minute
S or STBD--Starboard
S.C.DR.--Screen door
SDK--Shelter deck
$--Shear or seam
S.N.W.T.--Steel non-watertight
S.P.--Shell plate
S.R.--Stateroom
STIFF--Stiffener
STR--Stringer
S.W.T.--Steel watertight
T--"T" bar
T.C.--Towing chock
TEMP--Template
THD--Thread
THK--Thick
Trans--Transverse
T.S.--This side
T.S.U.--This side up
T.T.--Tank top
U--Up
UDK--Upper deck
V--Vent
V.K.--Vertical keel
V.L.--Vertical ladder
W--Weld
W.C.--Water closet
WL--Water line
W.R.--Wardrobe or washroom
W.T.--Watertight
W.T.M.H.--Watertight manhold
Z--"Z" bar

--Midship section

APPENDIX IV

Dimensions of Standard Iron and Steel Pipe

Nominal Inside
Actual Inside
Actual Outside
No. of Threads Per Inch
Length of Effective Thread
Length of Normal Engagement by Hand

E - Pitch Diameter at Gaging Notch

F - Pitch Diameter at Small End of Thread

G - Root Diameter at Small End of Thread

	A	B	N	C	D	E	F	G
⅛	0.269	0.405	27	0.264	0.18	0.3748	0.3635	0.334
¼	0.364	0.540	18	0.402	0.20	0.4899	0.4774	0.433
⅜	0.493	0.675	18	0.408	0.24	0.6270	0.6120	0.568
½	0.622	0.840	14	0.534	0.32	0.7784	0.7584	0.701
¾	0.824	1.050	14	0.548	0.34	0.9889	0.9677	0.911
	1.049	1.315	11½	0.683	0.40	1.2386	1.2136	1.144
1¼	1/380	1/660	11½	0.707	0.42	1.5834	1.5571	1.488
1½	1.610	1.900	11½	0.734	0.42	1.8223	1.7961	1.727
	2.067	2.375	11½	0.757	0.44	2.2963	2.2690	2.199
2½	2.469	2.875	8	1.138	0.68	2.7622	2.7195	2.620
	3.068	3.500	8	1.200	0.77	3.3885	3.3406	3.241
3½	3.548	4.000	8	1.250	0.82	3.8888	3.8375	3.738
	4.026	4.500	8	1.300	0.84	4.3871	4.3344	4.234
4½	4.506	5.000	8	1.350	0.88	4.8859	4.8313	4.731
	5.047	5.563	8	1.406	0.94	5.4493	5.3907	5.291
	6.065	6.625	8	1.513	0.96	6.5060	6.4461	6.346
	7.023	7.625	8	1.613	1.00	7.5023	7.4398	7.340
	7.981	8.625	8	1.713	1.06	8.5000	8.4336	8.334
	8.941	9.625	8	1.813	1.13	9.4980	9.4273	9.327
	10.020	10.750	8	1.925	1.21	10.6209	10.5453	10.445
	11.000	11.750	8	2.025	1.29	11.6194	11.5391	11.439
	12.000	12.750	8	2.125	1.36	12.6178	12.5328	12.433

APPENDIX V

Using The Sag Table

The sag table given on page 307 is applicable in all cases whe target stands for supporting the tight line are spaced 10 feet Where the total length of the tight line exceeds a distance whi be equally divided by 10 it is permissable to find the center betwe two extreme tight line supports and to work both ways from the cent the location of the target stands.

The two end distances may be slightly more or less than 10 For example: The total distance may be 172 feet from the extreme su of the tight line. Working from the center both ways gives fifteen exactly 10 feet apart. The two end spaces will be eleven feet. T FT. horizontal row of figures in the table will be used and t blocks will be placed on the target stands in the relative positions in the table.

The sag in the tight line for eleven feet at each end is or .0014 more than in ten feet. A .0015 shim may be placed unde sag block in every target which will support the tight line as as necessary for all practical purposes.

The example given above illustrates the procedure only in ar gency. Usually the target stands can be placed to have 10' b centers. Sometimes the last target stand may have to be placed feet further along than is required to obtain a measurement whi multiple of 10 feet between the two extreme target stands.

When the distance is a multiple of ten feet refer to the sag Assuming that this length is 110 feet the horizontal line in th which is marked 110 FT. is the line to use.

Ten sag blocks are required. The two outer sag blocks are thick. The next two sag blocks are 11/64" thick. The third p sag blocks measures 7/32"; the next pair measures 1/4"; and fina two center blocks measure 9/32".

The same size wire, .018, must be used at all times in connecti the figures given in this table. The same weight, 27-3/4 lbs also be used. It is desirable to use a 3/8" cord for the wei heavier cord is likely to be a little stiff and also adds slig the weight.

64	64	64	64	64	64	64	8	32	32	32	8	64	64	8	32	32	32	8	64	64	64	64	64	64	64	FT.	
15/64	7/16	5/8	31/64	61/64	3/32	7/32	5/16	25/64	29/64	1/2	17/32	17/32	17/32	1/2	29/64	25/64	5/16	7/32	3/32	61/64	51/64	5/8	7/16	15/64	260 FT.		
7/32	27/64	19/32	49/64	59/64	3/64	5/32	17/64	21/64	3/8	27/64	7/16	7/16	27/64	3/8	21/64	17/64	5/32	3/64	59/64	49/64	19/32	27/64	7/32	250 FT.			
13/64	13/32	37/64	47/64	7/8	1	7/64	3/16	1/4	19/64	5/16	21/64	5/16	19/64	1/4	3/16	7/64	1	7/8	47/64	37/64	13/32	13/64	240 FT.				
13/64	13/32	9/16	45/64	53/64	15/16	1/32	7/64	5/32	13/64	7/32	7/32	13/64	5/32	7/64	1/32	15/16	53/64	45/64	9/16	13/32	13/64	230 FT.					
13/64	3/8	33/64	21/32	25/32	7/8	31/32	1/32	5/64	3/32	7/64	3/32	5/64	1/32	31/32	7/8	25/32	21/32	33/64	3/8	13/64	220 FT.						
11/64	11/32	31/64	5/8	47/64	53/64	29/32	31/32	1	1/32	1/32	1	31/32	29/32	53/64	47/64	5/8	31/64	11/32	11/64	210 FT.							
3/16	21/64	15/32	19/32	45/64	25/32	27/32	57/64	29/32	59/64	29/32	57/64	27/32	25/32	45/64	19/32	15/32	21/64	3/16	200 FT.								
5/32	5/16	7/16	35/64	5/8	23/32	49/64	51/64	13/16	13/16	51/64	49/64	23/32	5/8	35/64	7/16	5/16	5/32	190 FT.									
9/64	9/32	25/64	1/2	37/64	41/64	11/16	23/32	47/64	23/32	11/16	41/64	37/64	1/2	25/64	9/32	9/64	180 FT.										
9/64	9/32	13/32	31/64	35/64	39/64	41/64	21/32	21/32	41/64	39/64	35/64	31/64	13/32	9/32	9/64	170 FT											
5/32	17/64	23/64	7/16	1/2	35/64	37/64	19/32	37/64	35/64	1/2	7/16	23/64	17/64	5/32	160 FT.												
9/64	1/4	11/32	27/64	15/32	1/2	33/64	33/64	1/2	15/32	27/64	11/32	1/4	9/64	150 FT.													
1/8	15/64	5/16	25/64	27/64	29/64	29/64	29/64	27/64	25/64	5/16	15/64	1/8	140 FT.														
1/8	7/32	9/32	11/32	3/8	25/64	25/64	3/8	11/32	9/32	7/32	1/8	130 FT.															
7/64	3/16	1/4	19/64	21/64	11/32	21/64	19/64	1/4	3/16	7/64	120 FT.																
3/32	11/64	7/32	1/4	9/32	9/32	1/4	7/32	11/64	3/32	110 FT.																	
3/32	9/64	3/16	7/32	7/32+	7/32	3/16	9/64	3/32	100 FT.																		
5/64	1/8	11/64+	3/16	3/16	11/64+	1/8	5/64	90 FT.																			
1/16	7/64	9/64	9/64+	9/64	7/64	1/16	80 FT.																				
1/16	3/32	7/64	7/64	3/32	1/16	70 FT.																					
3/64	5/64	5/64	5/64	3/64	60 FT.																						
1/32	3/64	3/64	1/32	50 FT.																							
1/64+	1/32	1/64+	40 FT.																								
1/64+	1/64+	30 FT.																									
1/64	20 FT.																										

TABLE OF SAGS
FOR NO. 7 MUSIC WIRE WHEN
USED ON REEL MADE FROM
ACC. DRAWINGS

WEIGHT USED
FILLED WITH
LEAD

DIAM. DRUM 3-1/2"
DIAM. PULLEY 7" (PITCH DIAM. CORD)
WEIGHT USED 27-3/4#
DIAM. CORD 3/8"
DIAM. WIRE .018"
AMT. WIRE ON REEL = ONE COIL
JOHN ROEBLING SON CO.
HIGH GRADE C. S. MUSIC

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